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THE MORRIS CANAL AND ITS INCLINED PLANES.*

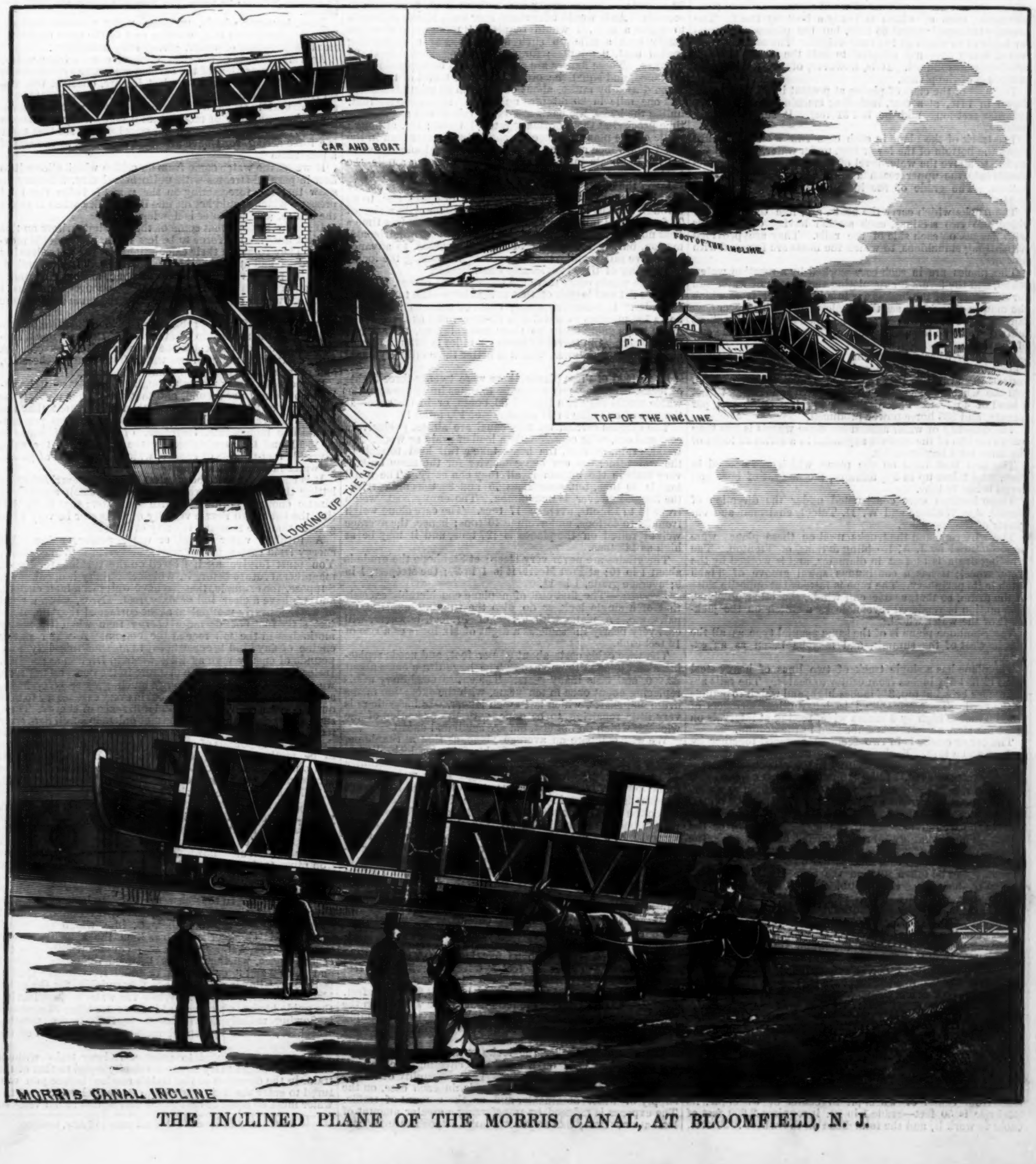
By HERBERT M. WILSON, C.E. ('81).

THE difficulty of raising canal boats over great falls, requiring a series or flight of locks, considerable time, and great expenditure of water in the operation, led to the adoption of other means, viz.: (1) perpendicular shafts; (2) inclined lifts, or planes. The former, though used on the Great Western Canal, England, are not of a sufficiently extended application to require attention. The inclined lifts, however, have been, and are at all times, for falls of considerable height, the most economical. Like many other things, these lifts were first carried out by the Chinese. The first application, however, to modern canal systems is due to William Reynolds, who introduced them, in 1792, in the Shropshire Canal. Subsequently, this system came into extended use on the canals of England.

THE MORRIS CANAL.

This canal was chartered December 31, 1824; began July, 1825, and completed from the Delaware River to Newark, during August, 1831, and extended to Jersey City in 1836. The planes and locks were enlarged in 1841. Its original dimensions were as follows: Canal—width at bottom, 20 feet; at top, 32 feet; depth of water, 4 feet. Locks—chambers, 9 feet wide by 75 feet long between miter-sills. Planes—to correspond with locks, first constructed on various plans, 20 summit and 3 lock-planes in all. The boats carried cargoes of 20 gross tons. During the winter of 1835-36, the summit-planes were altered to lock-planes. They were widened 2 feet, and the lock chambers enlarged to 11 by 95 feet in 1841. The canal was sold in 1844, and the new company organized October 21, 1844. In 1845, the canal was enlarged, the width being 25 feet at the bottom, and 40 feet at the top, and the depth increased to 5 feet. The section boats were first introduced in 1845, and carried cargoes of

* Abstract of a memoir submitted by Mr. Wilson.



THE INCLINED PLANE OF THE MORRIS CANAL, AT BLOOMFIELD, N. J.

45 gross tons. From 1850 to 1860, all the planes were again altered to summit-planes, rebuilt, and adapted to wire-rope haulage.

Elevations:

Mean tide-water to canal summit.

12 inclined planes	757 feet.	
16 lift locks	157 "	914 feet.

Delaware River (low water) to canal summit.

11 inclined planes	691 feet.	
7 lift locks	69 "	760 "
Total rise and fall		1,674 "

Summary of Cost in Round Numbers.

From Delaware River to Newark	$2,000,000
Alterations of planes in 1835–36	230,000
Extension to Jersey City in 1836	600,000
Greenwood reservoir and feeder	170,000
Enlarging planes and locks in 1841	400,000
Total	$3,400,000
Enlarging canals and rebuilding planes	1,700,000
Total cost	$5,100,000

The greatest rise in any plane is 100 feet, its length being 1,600 feet (near Washington, N. J.). The summit is at Port Morris, 41·34 miles from the Delaware River, and 60·80 miles from the Hudson River. The least rise of any plane is 44 feet. It is 3·4 miles from the Delaware, and 99·11 miles from the Hudson River. The whole length of the canal is 102·15 miles, the longest level (at Paterson) being 17·5 miles.

The boats, which are in two sections, are joined together by latches and steadying-pins, the ends abutting against each other. Transverse partitions of wood separate the two compartments, each of which is really a boat by itself. The average tonnage is about 65 tons, but the planes can transfer boats of as much as 100 tons weight. The sectional system of boats was not adopted to suit the planes, but was previously introduced. It is, however, of great advantage in the use of the planes.

The first of the class of planes at present in use was introduced in 1848, at a cost, including machinery, of $27,835. It is 900 feet long, and the fall 51 feet. It superseded six locks.

The track of the plane in each case runs a short distance along the bottom of the lower bay, under water, rises up the incline to above the water level of the upper reach, then descends into the upper reach and runs a few feet along the bottom. The grade of the inclines is, in general, about 1 to 11.

The trucks which carry the boats, are, like the boats, divided into two sections, each section having eight wheels with flanges on each side of the rails. They are provided with strong stanchions, to which the boats are fastened with hawsers.

The planes are in each case worked by a reaction water-wheel, and the levers for regulating the supply of water and for the control of the brakes are in a high tower, from which the man in charge can see the whole plane. This tower contains also the water-wheels and other machinery, and is about midway between top and bottom of the plane and at the end of the flume.

The water-wheels have four arms and describe a circle 12 feet in diameter. The openings for efflux of water at the ends of the arms are 15½ inches high by 3½ inches wide, and the wheel is placed far enough down the incline to get a head of 45 feet. The discharge is 1,000 cubic feet per minute, and 235 horse-power produced.

The quantity of water needed for these wheels is less than one-twentieth of the amount expended in a series of locks of the same total height or lift.

The first boat tried on the plane, which was opened in 1848, was taken up in 3½ minutes, the weight of boat and cargo being 70 tons.

These inclines were constructed under the direction of Messrs. Asa Whitney and W. H. Talcot, chairman and engineer of the company.

The wire rope and the trucks used on these planes were manufactured by J. A. Roebling & Sons, of Trenton. The winding drum is 12 feet in diameter, and is worked by the water-wheel; it has a continuous spiral groove of 3 inch pitch in its periphery. The rope is fastened at opposite sides of the drum, so that, as one end winds, the other unwinds. The motion is rendered reversible by a clutch on the jack-shaft of the water-wheel.

The Stanhope plane is of the same general type as all the planes west of the summit, and may be taken as an example.

The plane has a single track of two lines of heavy steel rails, 12 feet 4½ inches from center to center. The rails are 3½ inches broad at top, 3½ inches high, and weigh 76 pounds to the yard. They are spiked to longitudinal stringers of wood 6 inches high by 8 inches wide, resting at intervals on large flat stones two-thirds embedded in the ground.

The car or cradle is in two sections, fastened together by a chain and a link. Each section is provided with snubbing posts, by which the boat is secured in the proper position as it floats into the car. Long "fender" boards on each side serve to support the boat when it is hauled from the water.

The wire cables are so arranged, that as one winds on the drum the other unwinds. The two ropes pass around submerged horizontal sheaves at the bottom and top of the plane. The car has a wire rope attached at both ends, the "back rope" to one section, and the main rope to the other. The latter is fastened to a small drum on the car, by which the slack can be taken up and the rope kept taut. Each section of the car has eight double-flanged wheels, provided with brakes.

If the car is to be drawn out of the lower reach and up the plane into the upper bay, all that is necessary is for the engineer in the plane-house, called the "plane-man," to turn the "tub-wheel" which lets the water into the reaction water-wheel, and the drum winds up the cable at one end and unwinds it at the other, drawing the car up.

To take a boat down the plane, if it is empty, it is hauled out of the upper reach, the water shut off the wheel, and the car allowed to descend by its own weight. A boy on the car can apply the brake if the speed of descent becomes too great. If the boat is loaded, the plane-man puts on about half water—that is, opens the tub sufficiently to allow one-half the amount of water for full power of wheel. This prevents the boat from going down too fast. The planes west of the summit are uniform; those east of it vary somewhat. At Drakesville, for instance, the plane is 1,770 feet long from center of wheel-pit to center of wheel-pit; its total rise is 50 feet—grade 1 in 10; it requires 3,900 feet of cable to work it, and the total head on the wheel is 30 feet. It differs mainly from the Stanhope plane in having but two lines of cable instead of four, and but two grooved pulleys. This simplifies the construction materially, and makes a great saving in wire cable, pulleys, pulley-block stands, etc. Besides, the plane works more easily, and there is less slack. Instead of passing out in the same direction from opposite ends of the perpendicular diameter of the drum, it passes out in opposite directions from the same end of the diameter. Instead of being carried all the way on small pulleys, the cable is supported near the water's edge on two large vertical 11 or 14 foot groove-wheels. These wheels are in large masonry pits or slots in the ground, so that their upper surface is but a little above the surface of the ground.

All of the east side plane-houses are two stories high above the ground, instead of three stories, as on the west side, the brake and reversing-lever attachments being thereby greatly simplified.

All of the water-wheels are covered with a plate of iron, above and below; this entirely covers them, excepting a few inches over the nozzle. In all other respects these planes are entirely similar to the one at Stanhope.

At Washington and at Newark, there are planes of a different construction. These are double-tracked, two double lines of rails running parallel and the whole length of the plane. There are two cars, one ascending while the other descends, meeting half way. The cable is arranged as at Stanhope. This arrangement relieves the machinery of part of its work, as the descending car helps in raising the other one.

From careful observation, I find that to take a loaded boat up the plane at Stanhope, from the time it starts below until it just floats in the upper bay, it takes from 5 minutes 10 seconds to 6 minutes, the average being about 5 minutes 30 seconds. For lowering a loaded boat, on the average, about 2 minutes 40 seconds are required; for an empty boat, 2 minutes 50 seconds. For an empty car, without boat, 2 minutes 45 seconds. As it would take about four such planes in length to make a mile, it would require 11 minutes to draw an empty boat a mile up such a plane. For a descending loaded boat, 9 minutes; for an ascending loaded boat, 22 minutes. These figures are as near as can be approximately reckoned, and equal the ordinary rate of travel of the boats when drawn by mules, about one mile in 30 minutes loaded, and one mile in 20 minutes unloaded. Hence we see that, unlike the locks, the boats are being raised and at the same time proceed at their ordinary rate of travel; for, although while on the plane the speed is somewhat greater than in the canal, allowance must be made for the few minutes spent in getting the boats into the car; besides, in going a mile, the boat rises vertically about 300 feet on this particular plane.

From the above we find that while a boat takes probably about 8 minutes to go through a lock of 6 feet rise, to go through a flight of 12 locks, equal to a plane with a rise of 70 feet, would take 96 minutes; and during all this time a boat not only, in passing a plane, loses nothing in horizontal motion, but by the saving of time is enabled to advance about five miles while the other boat is passing the locks. The saving of time is evidently considerable.

On the whole canal there are twenty-three planes, with an average lift and length of that at Stanhope—the total length six miles. It takes the empty boats 66 minutes and loaded boats 198 minutes to travel this distance, and as there are as many boats going down as there are going up, the average time consumed in traveling these six miles is 133 minutes or one mile in 22 minutes, which is better than ordinary canal speed.

If, instead of these planes, there were twenty-three flights of locks, each one consuming 96 minutes in its passage, the whole would require a loss of 36 hours, or in distance—at the rate of one mile in 22 minutes—of 100 miles!

The cargoes carried on this canal are almost exclusively coal and ore, with occasionally a load of grain or wood. Of wood, grain, or coal, the boats take a full load to sink to the water-line, but ore being heavier for the same bulk, a very little in the bottom is all they can carry. The usual load is 70 tons, but sometimes 75 and 80 tons are carried; the latter, however, is uncommon. The empty boats weigh from 14 to 18 tons, average 17 tons. The cars alone weigh from 38 to 45 tons, and average 40 tons; hence, the average weight raised on the planes is 127 tons, and it may be as high as 143 tons.

The grades are never very steep; at Stanhope the grade is about 1 in 10; at Port Morris it is 1 in 20; the steepest, 1 in 9; average grade, 1 in 11.

Expenses.—The first cost of a plane considerably exceeds that of a single lock, as do also the running expense, repairs, etc. A plane with a rise of 70 feet, however, will cost very nearly the same as a flight of six locks of a rise of 12 feet each.

The wire cable costs about $1 per foot, and needs replacing about once in three years. The large drum costs about $3,000, and lasts many years. The entire machinery needs replacing about once in ten years, with the exception of the drum and shafts, which last much longer. In locks there is very little repairing to be done, with the exception of the wickets, which do not last, but are small and cheap.

We will compare an average plane, as that at Stanhope, with a lift of 72 feet, with a flight of twelve locks lifting each 6 feet. For a loaded boat, the plane takes 5 minutes 30 seconds = 330 seconds for passage. The water in the flume lowers 7 inches and flows at a velocity of 120 feet in 60 seconds = 2 feet in 1 second. The flume is 8 feet wide; hence the wheel consumes 8′ × 2′ = 16 square feet of water per second; this multiplied by 7″ in depth, gives the consumption of 9⅓ cubic feet per second; and if the boat takes 330 seconds for its passage, the total amount of water required to raise a loaded boat from the lower to the upper bay is 330 × 9⅓ cubic feet = 3,180 cubic feet. To take a boat down, the water lowers 1 inch; the velocity is 48 feet in 60 seconds, equal to about ¾ feet in 1 second; this multiplied by 8 feet, the width of the flume, gives 6 square feet per second × 1″ (the depth) = ½ cubic foot per second; and for 3 minutes = 180 seconds it takes 90 cubic feet of water, which is expended in holding the boat back.

In a flight of locks, each 95 feet long by 11 wide, with 6 feet rise, we have 95 × 11 feet × 6 feet = 6,270 cubic feet for only one lock; for twelve such locks, equal to a rise of 72 feet, the amount of water would be = 72,240 cubic feet. Hence, the locks expend about 23 times more water than the planes for a loaded boat, and 836 times more for an empty one. This item of economy of water is of prime importance in canals, especially in dry seasons.

The question whether the locks or inclines can be most advantageously used on a canal for effecting a change of level is not readily answerable. The advisability of adopting one system or the other depends, in each case, on the supply of water obtainable, and on the amount of traffic. The expense is reduced by transferring a greater amount of load at one time; this requires a large expenditure in construction, and the advisability of making such expenditure depends on the amount of traffic. The planes, however, cost very little more than a flight of locks of the same lift, consume less than one-twentieth of the amount of water required by locks, and save 60 per cent. in the time of passage, as the average rate of travel (four to five miles an hour) is continued horizontally while the car ascends the slope.

To sum up, one lock is more economical than a short plane; a plane is more economical than a flight or series of locks, especially in the items of water and time. A plane involves more machinery, details, etc., than a lock, but not so much as to make it more expensive than five or six locks in series.—*School of Mines Quarterly.*

HYDRAULIC MACHINERY.*

By PROFESSOR PERRY.

WHEN water is in steady motion from one place to another, if we consider that gravity is the only force acting on it, then the whole store of energy in a pound of water consists of:

Potential, h foot-pounds, because it is h feet above some datum level.

Pressure, 2·3 p foot-pounds, because the pressure is p pounds per square inch.

Kinetic, $v^2 \div 64\cdot4$ foot-pounds, because there is a velocity of v feet per second.

And however any of these stores may alter, the sum of all three remains constant, except that there is a loss at every place which is proportional to the kinetic energy. If at any place other forces than that of gravity act, we have a change in the total store, and we saw what this is in the case of pumps. Each pound of water gets an increased store of energy, which may be in the shape of pressure energy, or kinetic energy, or both, but which mainly becomes potential.

Now, in water wheels, turbines, water pressure engines, including hoists and lifts, we take part of the store of energy from each pound of water, giving it to machinery.

As a simple case of the abstraction of energy from water, and as an illustration of the acrobat and railway-train principle which I gave you in my last lecture, consider this vessel from which the water is flowing. Water leaves this vessel horizontally from an orifice, taking away with it momentum. The quantity of momentum it takes away per second is simply the force acting on the vessel. You see that there is a force acting, for I have arranged the vessel as the bob of a pendulum.

If we let the water come from an orifice which allows it to flow in parallel streams with uniform velocity, it is easy to show that the force acting on the vessel is twice the total pressure which would act on this little sluice when it closes the orifice, and no water is flowing.

It is very strange that some of the soundest writers on this subject imagine the force to be less when the vessel is moving. They forget in their calculation that the water leaving the vessel had at the beginning the motion of the vessel itself. Here is a vessel floating on a pond, and moving under the action of this jet. If I had delicate enough apparatus, I could show you that the force on it is the same as if it were at rest.

It is a very different problem to consider the force of propulsion on the steamship Waterwitch. Here we must consider that the acrobats enter the train as well as leave it. A large centrifugal pump draws water from beneath the ship, and propels it out at the sides and sternward.

Suppose the water moves through the nozzles with the velocity of 30 feet per second, and that the ship is moving the other way at 20 feet per second, then it is evident that the water has a velocity relatively to the sea of 10 feet per second. The momentum, therefore, of a pound of water is $\frac{1}{32} \times 10$, and this, multiplied by the velocity of the ship, gives 6¼ foot-pounds of energy, which each pound of pumped water imparts to the ship.

It is easy to see that the greatest efficiency is arrived at by letting the water take with it only a very small amount of kinetic energy as it mingles with sea water; that is, by letting the backward nozzle velocity of the water be very little greater than the forward velocity of the ship.

A turbine, water wheel, or water power engine takes energy from each pound of water, and gives it to machinery. You must forgive me if I dwell on the turbine, for I see a magnificent future before it, which electricity is opening up. Suppose, for example, that we have water in a tank or dam, and we have a clear fall of sixty feet. Now, when a pound of water is nearly motionless at the surface of the dam, it has just sixty foot-pounds more energy than when it is nearly motionless in the tail race at the bottom. A water power engine of any kind is constructed to abstract this sixty foot-pounds of energy with as little waste in friction as possible. Instead of being at the same pressure in the dam and tail race, we may have the pressure energy much greater beforehand, as well as the potential energy; but in every case we try to take out of a pound of water the total difference of energy. Thus, suppose a pound of water to be motionless in a mill dam sixty feet high above the tail race, we cannot take more from it than sixty foot pounds of energy. Suppose a pound of water to be motionless sixty feet above the tail race, but that it is also inside an accumulator, where the pressure is 700 lb. the square inch; we can take from it $60 + 2\cdot3 \times 700$, or $60 + 1{,}610$, or 1,670 foot-pounds of work.

If you have understood the action of the centrifugal pump, you will have no difficulty in understanding the action of the turbine. It is because you have studied the centrifugal pump that I mean to dwell upon this turbine of Prof. James Thompson. Water flows from a pen trough through cast iron pipes to A. Remember our old rule; these pipes must be bell mouthed; they must open out gradually into the cistern; they must be as large in diameter as we can conveniently make them. In that case the velocity in the pipes will be small, and, therefore, the friction will be small. Fig. 1 shows a plan of this chamber, B, into which the water flows. This chamber is so large that the velocity here is small, and the water finds its way equally readily into the central space, whether it flows between the guide blades 1 and 2, or 2 and 3, or 3 and 4, or 4 and 1. Observe that at last we are allowing the water to flow quickly, for the guide blade chamber is narrow. When the water is just leaving the guide blades, observe that it flows rapidly; of course it is flowing radially as well as tangentially to the rotating wheel, W, but the tangential motion is equal to that of the wheel.

Suppose you wanted to enter a railway train without shock, you ought to try to get a velocity equal to that of the train, in the direction of the train's motion, before you ventured to enter the train; hence the tangential velocity of the water must be equal to that of the end of this radial vane of

* From lecture delivered before the Society of Arts, London.

the wheel, if the water is to enter it without shock. If the vane here is inclined like Fig. 3, A, the tangential velocity of the water ought to be less than that of the wheel just here. If the vane here is inclined like Fig. 3, B, the tangential velocity of the water is made greater than that of the vane. In fact, you see that the relative velocity of water and vane must be in the direction of the vane, if there is to be no shock. Usually the vane is shaped as you see it in Fig. 2, which is an enlarged section of the wheel, W; but I will suppose it to be radial just at the outside, for simplicity of calculation. Remember, then, that, somehow or other, we must try to get tangential velocity of water, equal to velocity

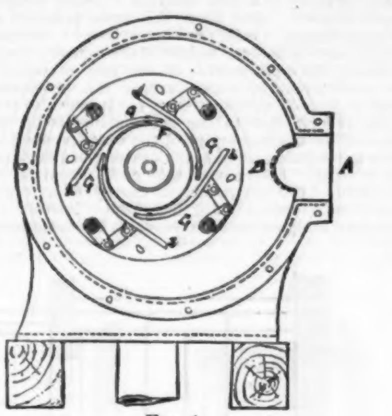


FIG. 1.

of vanes there. The water now flows through the wheel, which lets it escape at the center. Here, again, we must remember that the water has to escape with no velocity, except a radial one.

If we wanted to let a stone out of a railway carriage so that it would just fall to the ground vertically, so that it would possess no forward motion, you know quite well that you would have to shy it backward, with respect to the train; give it a velocity backward as much as it has forward already. These vanes, then, at the center, let the water out backward, just because we want the water to have no forward velocity when it has left the wheel. The water has,

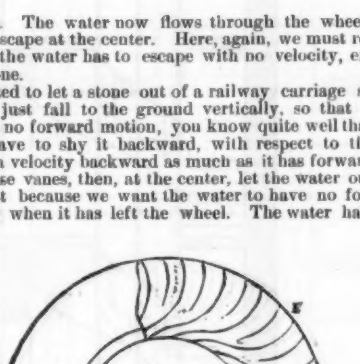


FIG. 2.

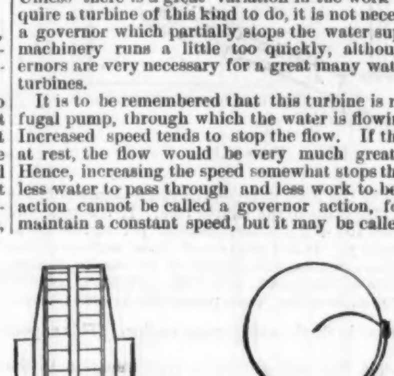


FIG. 3.

of course, a radial velocity everywhere which simply depends on the total quantity flowing per second, divided by the tangential areas of these orifices.

We want, now, to know how much store of energy has each pound of water lost in passing through the wheel, and we employ the rule I told you about before. Get the tangential momentum of the water at F. We have one pound of water, and if the velocity of the outside of the wheel is v, then $1 \div 32 \times v$ is the forward momentum of one pound of water. This, multiplied by v, is the work done by the pound of water, or—

$v^2 \div 32$ foot-pounds,

because it enters the wheel. Now, you see that the wheel does no work on the water, as it leaves at K, because the

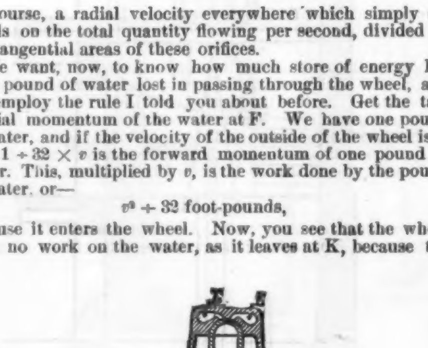


FIG. 4.

water leaves with no forward or backward momentum. Hence one pound of water, from the time it enters the wheel to the time it leaves, loses

$v^2 \div 32$ foot-pounds

from its store of energy, and gives this store to the wheel.

If, then, it loses no energy by friction anywhere when it enters the tail race, it has just this much less energy than when it left the pen-trough. If h is the total height of the fall, evidently one pound of water really gives out h foot-pounds of energy. We know that in practice, what it gives to the wheel is only a portion of this, and

$$\frac{v^2}{32} \div h$$

is called the hydraulic efficiency of the turbine. It is the ratio of the energy given to the wheel to the total energy lost by the water in falling from one level to the other. If, then, there is no shock to the water in entering or leaving the wheel, its efficiency is twice the height due to the velocity of the rim divided by the real total fall of the water.

Of course all the energy given to the wheel is not utilized. Remember that there is friction between the wheel covers and the wheel case, friction at all the bearings, etc., of the shafting, which transmits the power of the wheel to a mill, etc. I am only speaking now of the efficiency of the passages through the wheel, which is, however, the most important matter in connection with turbines.

Knowing the average amount of water passing through the wheel, and therefore the radial velocity at K, the angle of the vanes at K is determined if we know the average speed of the wheel. If the speed and quantity of water were exactly proportional to one another, that is, if the speed of the wheel were exactly proportional to the horse power, the inner ends of the vanes once settled would remain right always. But if our wheel is to be regulated as a steam engine, so that quickening speed causes less water to flow, then it is obvious that the inner ends of the vanes, although right for the calculated flow, are not properly shaped when the horse power diminishes or increases. The loss of energy here is not, however, likely to be great in any case.

It is different at the entrance to the wheel, F. Unless the guide blades are directed so as to give a tangential velocity to the water equal to that of the wheel, there is a considerable loss by friction at F.

Suppose that less water flows through the turbine, the inclination of the guide blades ought to alter, and this arrangement of links, which you see in the drawing, is for the purpose of making the guide blades alter their inclinations to the wheel. Each guide blade is pivoted at its extremity, K, and when one is shifted they are all shifted in position. Unless there is a great variation in the work which we require a turbine of this kind to do, it is not necessary to apply a governor which partially stops the water supply when the machinery runs a little too quickly, although such governors are very necessary for a great many water wheels and turbines.

It is to be remembered that this turbine is really a centrifugal pump, through which the water is flowing negatively. Increased speed tends to stop the flow. If the wheel were at rest, the flow would be very much greater than it is. Hence, increasing the speed somewhat stops the flow, allows less water to pass through and less work to be done. This action cannot be called a governor action, for it does not maintain a constant speed, but it may be called a steadying action, as it prevents any great change of speed, even for a considerable alteration in the work done.

Except at the speed for which the positions of the guide blades are fixed, there is some loss in friction, and the guide blades are rearranged should any considerable change be meditated in the power to be given out.

I hope to measure the horse power given out by this turbine.* I have made it drive this absorption dynamometer, which is much the same as the one used by Thompson in gas engine trials recently. You see that I can measure how much water is flowing; I know the fall, and I can calculate the horse power of the fall itself, and thus get the efficiency. Of course it is unfair to regard the efficiency of this hastily arranged turbine as representing in any way the efficiency of a large specimen.

On the large scale I do not care to use absorption dynamometers for measuring horse power; the heating is too great, unless there is an exceedingly large amount of cooling water used, and the water causes treacherous alterations in friction. I prefer to drive by belting through our transmission dynamometer, or to use this simpler form as a shaft coupling. You see that if this dynamometer coupling is used instead of an ordinary coupling for two lengths of shaft, the whole torque transmitted through the shaft must be transmitted by these strong spiral springs. The yielding is small, but becomes magnified into a very large yielding of this bright bead. When the coupling is revolving, the position of the bead is well marked on this dark ground, describing large or small circles. Its distance from the center is readily measurable on scales, which we fix to the wall, or a bracket close in front; and the distance from the center tells us the transmitted torque. In fact, the reading on the scale, multiplied into the speed, is the horse power transmitted. Suppose there is a coupling of this kind on any shaft in any room of a factory; the foreman can tell roughly from a distance about how much horse power is being transmitted, even if he does not care to measure it carefully on the scale. These couplings are more immediately intended for use on dynamo-electric machines, no one of which ought to be driven without such tell-tale of the horse power given to it; but I consider they would be valuable on turbine shafts; nor would it be difficult to automatically govern the positions of the guide blades from the yielding of the couplings.

In arranging a turbine, it is obvious that the great point to settle beforehand is this: What ought to be the speed of the wheel for a given height of fall? If there were no loss in friction, we could say at once, if v is velocity of rim of wheel, $v^2 \div 32$, the total loss of energy by one pound of water, ought to be equal to h; that is, the velocity of the wheel ought to be that due to half the height of the total fall of the water. Thus, for a fall of 60 feet in height, half of this is 30 feet; and if a stone fell 30 feet, it would be falling with a velocity of 43 feet per second. The rim of the wheel ought to have a velocity of 44 feet, then, per second, and it is easy to show that, wherever the turbine may be placed, whether it has a long discharge pipe, or is submerged, as shown in various diagrams and models here before you, the water may be made to flow tangentially into the wheel with the same velocity as the wheel itself has.

But we have usually to calculate on the assumption that a certain fraction of the energy of the water is wasted in the supply and discharge pipes, and the discharge chamber, and hence, the velocity of the wheel is less than that due to half the height of the fall.

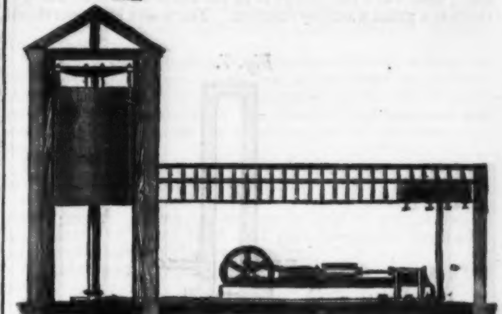


FIG. 5.—ENGINE, PUMP, AND ACCUMULATOR.

It is usual to assume that the radial velocity of the water through the wheel is one-eighth of that due to the total fall. Dividing this into the number of cubic feet of water flowing, you know the total tangential area of the space between the vanes everywhere in the wheel, assuming that it is the same everywhere, which it usually is. It is usual to take the inner radius of wheel equal to the depth of these passages in the wheel, so that both these dimensions are now fixed. The outer radius is generally twice the inner one, and we have already calculated the tangential velocity of the outside, so the number of revolutions per minute may be calculated. The horse power given out is usually taken to be less than three-fourths of the true horse power of the water. Thus, by rules, partly due to practical experience and partly due to imperfect theory, we are able to fix all the dimensions of a turbine of the kind I have been describing.

I think that, by entering thus fully into the theory and construction of the turbine, with which I am, myself, practically acquainted, I can dispense with giving a catalogue of the constructions of turbines generally. This turbine is said to be one of "inward radial flow." You see that, for a given quantity of water flowing, it can be made hydraulically perfect, that is, by proper construction of these guide blades there is no necessary loss of energy, any more than in the whirlpool chamber of Thompson's centrifugal pump. Water need not flow from any one place here to any other

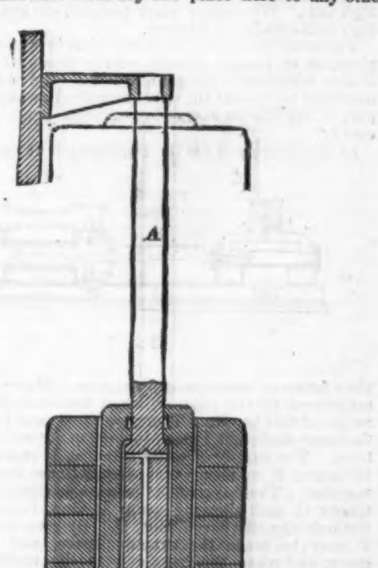


FIG. 6.

where there is necessarily, from the shape of the stream lines, a difference in the amount of total energy per pound of water.

You see that, in the same manner, we could discuss the action of water in the unsteady "outward radial flow turbines," and, again, in the axial flow turbines of Fourneyron and others. The principle of your stream of acrobats jumping on and off a merry-go-round will in every case tell you how much energy the water gives to the wheel of a turbine, whatever may be the nature of the flow. In the same way, also, we consider the construction of the floats of undershot water wheels, and all other wheels on which the water acts impulsively; that is, the water possessing only a portion of its store in the shape of pressure or potential energy;

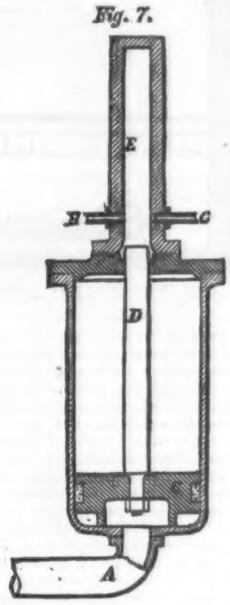
* Here various measurements and calculations were made as to the efficiency of the model of Professor Thompson's turbine, working on the lecture table.

much of its energy being kinetic when it is entering the vanes.

I wish I had time also to tell you about the action of air in motion on windmills. The action of air on the sails of a windmill is pretty much the same as its action on this little ventilation gauge; and I hope that some of you will be sufficiently interested in this matter to get these little models of windmills and anemometers explained to you at the end of the lecture.

When the available fall is very great, it is not advisable to use a turbine water wheel. In the turbine, as you saw, there is at least one part of the arrangement in which about half the total store of energy is in the shape of kinetic energy; and when the energy is in the shape of kinetic energy, there is a great waste by friction. The waste is proportional

Fig. 7.



to the kinetic energy, that is, to the total energy, and hence turbines are at least not more economical on high falls than on low ones.

Now, a water pressure engine may be regarded as the inverse of a reciprocating pump. If we neglect the shocks which are always due to imperfect construction, when a water pressure engine works at a certain speed the loss of energy by friction in the engine is the same on high and low falls, and hence there is a very much greater efficiency on high falls. We employ water pressure engines, therefore, on high falls instead of turbines.

You must remember, however, that in water pressure engines, as in pumps, kinetic energy produced anywhere is almost immediately altogether wasted. Tweddell's punching machines are almost the only examples in which even a small part of the kinetic energy is converted again into pressure energy.

In this figure you see the construction of one of the sim-

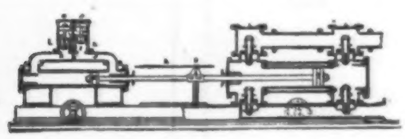


FIG. 8.

plest forms of water pressure engine. Water enters the arrangement by the pipe, A, when the cock, B, is opened by means of this handle. There are three rams here, all driving the same shaft, but I mean to confine my attention to one of them. The supply of water enters at A, and finds its way to the space, F, by means of a passage in the framework of the machine. There is another passage leading to the exhaust spaces, G, and allowing water to flow from these spaces through the discharge pipe, Q. By reversing the handle, F may be made the exhaust space, and G the supply space, and when the handle is in the middle position, it acts as a brake, so that, by means of this handle, we can make the engine work in opposite directions, or stop it altogether.

Remember now that water is at F, and fills the space, J, and its energy is all pressure energy. It presses on the ram, C, causing it to leave more empty space behind it. You know now how to calculate the force with which the plunger

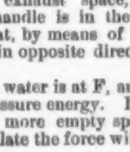


FIG. 9.

is being pressed. The plunger cannot go out without turning the crank, H K. You observe, too, that there is no connecting rod; the cylinder, J, turns just like the oscillating cylinder of certain steam engines. When the crank reaches its dead point, the plunger can go out no further; but when this happens, the orifice, L, is just ceasing to let water enter from F, and is beginning to let the water escape into G. As three plungers act on the same crank, the crank does not stop anywhere, and as it moves on, the plunger, C, comes back again, driving the water from J through L into G and away by Q.

This is all exceedingly simple. The quantity of water used in one stroke of C is simply the volume of C which leaves J in one stroke, assuming that the water can come in quite freely. Each pound of this water has a certain amount of pressure energy, which it gives up to the plunger, and which you may take to be the pressure energy in F, minus the pressure energy in G. This is only true if we assume that the water has no kinetic energy where it is in contact with the plunger; but as the plunger is itself moving, we know that we are here making a small error. We are also assuming no loss by friction at the passage, L, which is again an error.

So long as J is considerably less than 34 feet above the place in the pipe, Q, where there is considerable pressure, it is evident that, neglecting kinetic energy and friction, every pound of water loses 100-foot pounds of energy in passing from F through J to G, if the total fall is 100 feet. Knowing how many pounds of water enter and leave at one stroke, we have the total energy given to one plunger. Three

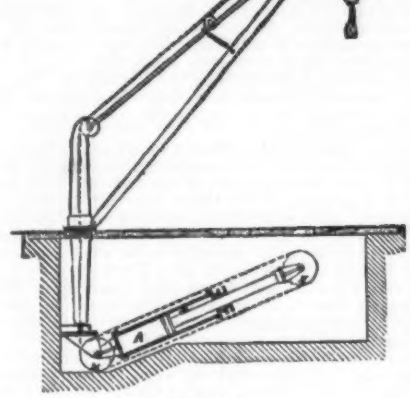


FIG. 10.

times this will be the work done on the three plungers in one revolution. This leads to the simple rule: If the total fall is 100 feet, then $100 \div 2\cdot3$ is the pressure per square inch. Call the pressure p. If a is the area of cross section of the plunger in square inches, l the length of the stroke, that is, twice the length of the crank, and n the number of revolutions per minute, then the horse power due to *each* plunger is $\frac{p\,l\,a\,n}{33,000}$, just as in single acting steam engines. This engine is so very simple that one dislikes to draw attention to the fact of there being a great deal of wire drawing at these slide valves.

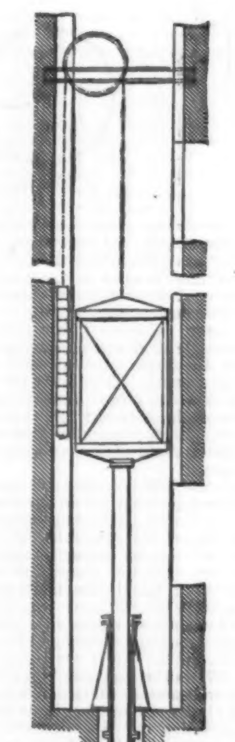


FIG. 11.

You observe that I spoke here of the total fall of the water. Remember, however, that we do not care where the water comes from or goes to; we are really only concerned with the difference between F and G. The water may have flowed from a reservoir, with its surface exposed to that of the atmosphere, but then, again, it may not. Thus, for example, in this model, when I turn this handle, I pump water into a little water-pressure engine, somewhat like the one I have been describing, and the water-pressure engine works, turning the capstan, as you see. When I cease turning, the engine ceases to work; and if the supply valve of the engine is closed, I find that I can pump no longer.

Now, I showed you in my first lecture, that water-pressure engines, moving slowly, can be made very economical; and I mean presently to show you how easily we can work pressure engines from a steam engine at a considerable distance. But there would be great difficulty introduced if, every time I stopped my water engine, whether it was part of a crane, or a capstan like this, or a riveting machine, or a punching machine, or a hoist, my pumps were compelled to stop, and therefore my steam engine. I want my steam engine to work continuously, storing energy in the shape of pressure or potential energy in water, so that I may draw on this store intermittently. It is seldom that the energy is stored as the potential energy of water raised to a tank. The usual arrangement for storage is called an accumulator, like this shown in the figure.

Here (Fig. 5) is a ram carrying a heavy weight; every pound of water taken from this press possesses a store of pressure energy, which you know how to calculate. The pressure here is the total weight of the ram and accumulator, divided by the cross section of the ram in square inches, and every pound of water leaving this accumulator possesses a store of pressure energy. It may also possess potential energy, due to the accumulator being above the mouth of the discharge pipe of the water-pressure engine.

For the working of cranes, a pressure of 700 lb. per square inch is usual. This means that each pound of water has $700 \times 2\cdot3$ or 1,610 foot-pounds of energy, or as much as if it came from a cistern 1,610 feet high. Instead of coming from such a high cistern, however, it has come from this ac-

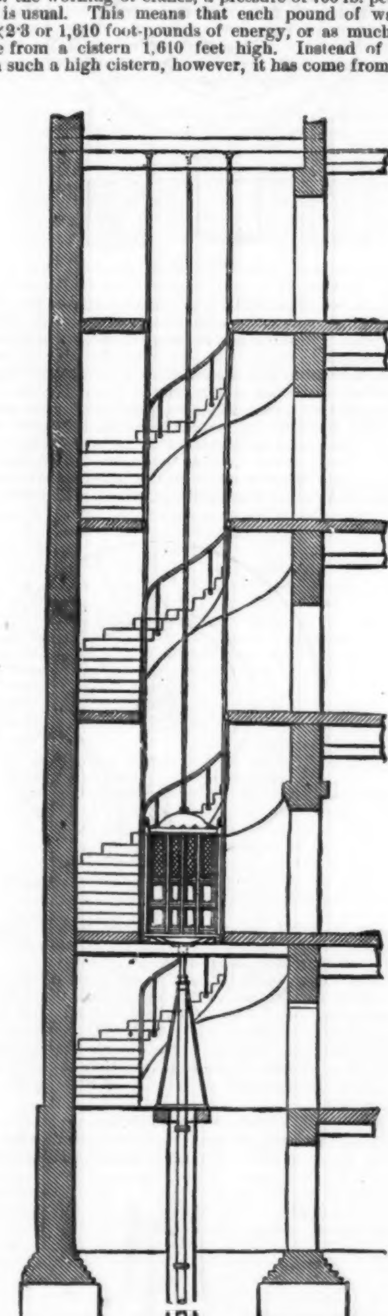


FIG. 12.

cumulator, on which the load on the ram is 70,000 lb., the ram having a cross section of 100 square inches. If this ram can be lifted 20 feet high, before the self-acting mechanism shuts off supply from the steam engine pumps, it is capable of containing a total store of $70,000 \times 20$, or 1,400,000 foot-pounds; the store of one Faure's electric accumulator; enough energy to drive a machine requiring one horse power for forty-two minutes.

As an illustration of the small amount of loss of energy in this form of storage, I quote from Mr. Tweddell, when using an ordinary accumulator with a 7 inch ram, 12 feet stroke. When being charged, the pressure was 1,250 pounds per square inch, and when being discharged the pressure was 1,225 pounds per square inch. So that in each case, friction is overcome with a pressure of 12½ pounds per square inch, or one per cent. of the energy is wasted in friction in charging or discharging. In fact, 98 per cent. of the energy given to such an accumulator is given out again. I am sorry to state, however, that other experienced men state the loss at 20 to 30 per cent., although I know of no recent figures derived from actual experiment which make the loss so great as this.

If we want our water to have a greater pressure, we can either increase our lifted weight or diminish the section of our ram. There is a limit, however, beyond which it is unadvisable to lessen the size of the ram when a great weight is

being carried, and this is specially the case when the accumulator has to be shifted in position.

Fig. 6 shows a small accumulator of Mr. Tweddell's, in which the lifted weight contains the heavy press which is usually fixed. Here it is the accumulator ram, A, which is fixed, and it admits water through its center. But it will be observed that there are two glands; the ram continues right through the cylinder, coming out above, but of a smaller diameter. Hence the total weight may be regarded as giving pressure, not to the area of cross section of the ram, but to the difference of cross section between the two portions of the ram. By means of this principle the pressure may be made as great as we please, and, at the same time, we have a very rigid guide for the motion of the weight.

Mr. Tweddell wanted to work some of his riveting and other tools, which require a water pressure of about 2,000 lb. per square inch, in shops where there were already in existence accumulators giving a pressure of 700 lb. per square inch, or where there was a quantity of water at a much smaller pressure than this. He allows his present supply to press on the under side of the piston, C, Fig. 7, and he lets this act on the ram, D, which has, of course, a much smaller cross section. The water in the press, E, will, therefore, have a greater pressure just in the ratio of the area of the piston, C, to the cross section of the ram, D. He pumps in water at G, and takes it off at H, and C is merely used for regulating the pressure in E. He does not waste the supply which comes through A. A empties or fills just as an ordinary accumulator load rises or falls. This, then, may be regarded as a great improvement on the ordinary accumulator, as an accumulator in which the weight raised and lowered is a quantity of water in a tank which need not be in the neighborhood. If the supply pipes, A, are large, and have easy bends, it is even possible to get from such an accumulator the momentum effect which Mr. Tweddell relies upon for riveting.

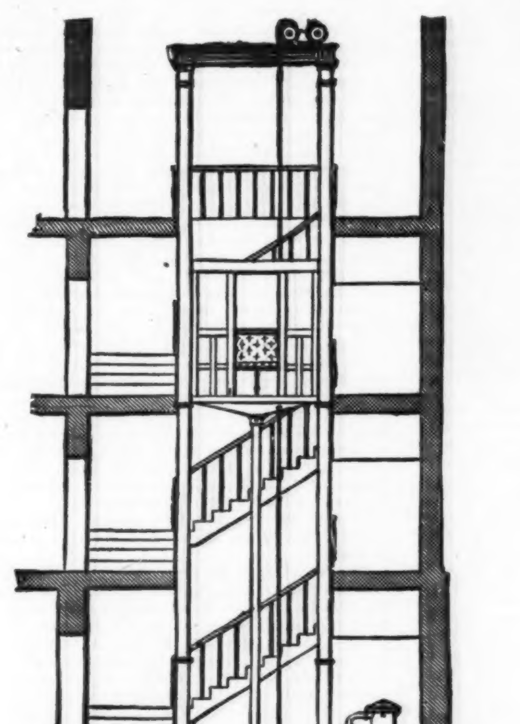
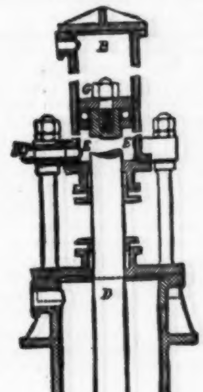


FIG. 13.

FIG. 14.



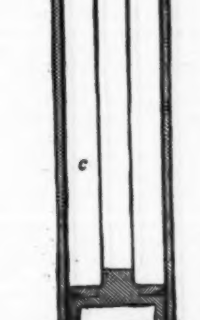


FIG. 15.

In the wall diagram you see a Brotherhood engine working by water instead of steam. Water is admitted and exhausted to and from the outer ends of the three plungers which work on one crank.

In most engines of this kind the work to be done per stroke may be very different at different times, and yet the pressure water used, that is, the energy, is always the same, and so there is considerable loss. Mr. Hastie's method for remedying this evil is to shorten the crank, as the work being done is less, and by rather complicated mechanism he effects this purpose.

Another method which has been suggested, is that of admitting pressure water for less than the whole stroke, simply taking water from the discharge pipe for the remainder. It is probable that this idea will have a large development. When engines have a fixed sort of duty, there is no need for any adjustment.

The common construction of water pressure engines will be readily understood, if you understand the construction of the steam engine. Remember, however, that the velocity of water ought never to be great in the engine or pipes. Wire drawing leads to serious loss by friction in the steam engine; it is far more serious in water pressure engines. In these, the valves ought to be quite open, giving a very large passage for water to flow through almost immediately. Hence, although the slide arrangements of Fig. 4 and of some others of these wall diagrams are allowable in small engines, they cannot be used in large economical engines working constantly. Remember, too, that all frictional losses are made much greater by quick motion, and by reversals of motion, and hence that it is very important to have a long stroke of piston or plunger.

Lastly, remember that, although there ought to be no waste space between steam piston and cylinder, at the end of the stroke (very little clearance), this is of almost no importance in water pressure engines, because of the incompressibility of water.

The working of the valves of non-rotative water-pressure engines is always pretty much of the same kind, and it will suffice for all such valves if I describe to you the valves of one of Mr. Davey's engines.

In Fig. 8, water from an accumulator at the top of a mine is admitted alternately on either side of the piston, Z, and exhausts into a pipe, which takes it back again to the surface. The difference of pressure on the two sides of Z is, then, merely the pressure due to the accumulator. The piston rod becomes the pump rod, and works (Y) the piston of a double acting force pump, which lifts water from the mine, and raises it to the surface. Indeed, the discharge pipe of the engine is also the discharge pipe of the pump. The pump, as you see it, has a liner. If this is removed, and a larger piston be fitted on, the pump can discharge twice as much water to half the height. But now I don't want to consider the pump; I want mainly to consider the valves which admit water from the accumulator to one or other side of Z.

As you see, in the valve-case, Fig. 8, water is admitted through F, by the open valve, L, to the space, K. The exhaust water is flowing from J, through I, to the pipe, G, which is the discharge pipe. Z is pressed from left to right. When it gets to the end of its stroke, the rod, R, moves, because the arm, S, strikes a tappet on the rod; the rod, by means of a lever, moves a slide valve, which admits supply water above N¹, and lets the space above N communicate with the exhaust-pipe. You will observe that now there is unbalanced downward force acting on H¹, which falls till the lower part fits its seat, I. The mushroom valve, L¹, continues to fall, and thus the space, J, is at high pressure. But there is more pressure below N than above it, and consequently it rises, closing first the valve, L, and continuing its motion, partly by its momentum and partly by the pressure at K being a little greater than at G or the space above N, lifts H, and leaves the space, K, in communication with G, the discharge pipe. Thus we have now J at high pressure, and K at low pressure, and the piston, Z, is pressed from right to left. The valves are reversed in their action at the end of every stroke through the agency of the tappets on the rod, R, and thus the piston will continue moving backward and forward so long as high pressure water is supplied, and so long as the resistance to motion of the pump-piston is not too great.

It will be observed that there is no sudden stoppage of the flow of water from F, for when the main piston is at rest, H or H¹ is falling and letting the water flow from F behind it, or behind N or N¹. This affords, then, a partial remedy for the shocks due to change of velocity in the supply and discharge columns of water. Again the motion is everywhere slow, only twelve double strokes being made per minute.

You must remember that, on account of the comparative incompressibility of water, a sudden stoppage of flow in pipes means a very severe impact. The weight of a ton pressing this hammer against this steel surface might not indent it, whereas the sudden stoppage of the hammer's motion means a tremendous force, quite sufficient to hurt the surface.

You know that this weight, A, cannot lift this weight, B, but if I suddenly stop A's motion, B is raised, as you see. [Some other designs of pumping-engine by Mr. Davey were here shown and explained; the general arrangements are somewhat different, but the valves are just of the same construction.]

What now are the conditions under which transmission of power by hydraulic action is most suitable?

1st. Intermittent action, because the accumulator is so nearly perfect, giving out energy simply in proportion to the quantity of water used, and yet allowing an engine of small power to be storing continually.

2d. Action requiring not a very great quantity of power.

3d. Action of a comparatively slow kind, the water never being allowed to flow so fast that its store of kinetic energy is great, since the kinetic energy is nearly all wasted. Slow action with considerable force.

4th. Action which is greatly continuous in one direction, not requiring much stoppage or reversal of the water motion.

You will see from this, that the conditions required in pressing machinery, cranes, hoists, and lifts are better satisfied by hydraulic transmission of power than they can be by any other method of power transmission which is known to us. You are aware of the fact that pressing machinery can be made to act in a very efficient manner by the agency of water.

In this figure, and in the other wall sheets, you see specimens of the ordinary forms of hydraulic crane, whose action it is very easy to be understand. Suppose water at 700 lb. pressure per square inch admitted to this space, A, and that the space, B, on the other side of the piston, although filled with water, has only a comparatively small pressure, and communicates with a low-lying tank; neglecting the small pressure in B, we see that the piston is pushed forward with a force of $700 \times \frac{\pi d^2}{4}$, or $\frac{700\,\pi d^2}{4}$ lb. Now the motion of the piston is multiplied eight times by this chain, which passes over blocks, each containing four sheaves, attached at M and N. The block at M gets the motion of the piston, and the chain at P must be drawn in eight times more quickly than this. You saw, from my first lecture, that the pull in the chain may be one-eighth as much as the total pressure on the piston, and it can therefore lift through eight times the distance a weight of one-eighth the amount.

It is unfortunate that, in modern hydraulic cranes, there has not been much attempt at improvement on the original form of Sir Wm. Armstrong. Whatever defect there is, lies in the use of chains passing over numerous sheaves, giving rise to a great amount of friction. Cranes require so little horse-power to work them, however, that mere economy of coal is barely worth considering, and the risk of accident, which might be done away with very greatly by direct hydraulic action, is not important either. You see that if A and B are communicating with the accumulator, there is less water used than before, for although as much comes into A as before, B is sending water back to the accumulator. In fact, the total pressure on the piston is 700 lb., and the difference between the areas of the two sides of the piston exposed to pressure, that is, the mere area of cross section of the piston rod. Hence we can work this crane so that it lifts heavy loads or light loads, that is, it is double powered. Unfortunately, however, when working any heavy load it is consuming as much energy as if it were lifting the heaviest load it is capable of lifting. When lifting on its second power, and lifting a light load, it is using as much energy as if it were lifting the heaviest load this second power is capable of lifting.

Thus, let us suppose it lifting eight tons to a height of 20 feet, and that one cubic foot of water is used in the operation. Then, on the same power, suppose it to be lifting four tons to the same height, it still uses one cubic foot of water; and in both cases there is the same energy drawn from the accumulator. Of course, by a combination of cylinders, like A, B, it would be possible to vary the work expended as the load varied, but the expedient is not of a very practical character. From the scientific point of view, it seems a pity that economy is of so little importance in crane work, for if it had been of importance, I feel sure that large advances would have been made in the last twenty years.

You all know the conditions required in an ordinary hotel or chambers hoist; those conditions are absolutely the same for warehouse hoists, because a hoist which carries goods occasionally carries men in charge of those goods. Long ago, I had some designing and carrying out of mill hoists, in which the cage was lifted by a rope passing over an elevated pulley, driven from the main shafting of the mill, and stopped at any point of ascent or descent by automatic disengaging apparatus which also braked the pulley. The cage was balanced by counter-weights, as a window is balanced. Our greatest trouble was in the arrangement of safety apparatus, which would stop the cage in falling should the rope break. Now it is well known that such safety apparatus can never be thoroughly depended upon, however ingenious its design may be, because the ordinary working of the hoist does not keep the safety apparatus in action; immunity from accidents causes it to be neglected, and when an accident does happen, it won't work.

There is nothing so safe as a hoist whose rapid motion is resisted by a considerable amount of friction. But, unfortunately, if the friction is that of solids on one another, there is as much frictional resistance to the ordinary working of the hoist as there is when an accident occurs, and hence assurance of safety by friction means tremendous loss of power at all times.

Now, you remember that the frictional resistance of water was of quite a different kind. There is almost no resistance

to the flow of water, if the flow is slow. There is only a moderate loss of power in the ordinary use of a hydraulic hoist; but the motion cannot become too rapid for safety, for the frictional resistance is exceedingly great at high speeds. A hydraulic hoist, then, can be made perfectly safe without the use of ingenious mechanism.

In a great many hydraulic hoists the action is precisely the same as in Armstrong's cranes. Fig. 15 shows such a construction, used by Armstrong himself. A is a pressure cylinder with its ram carrying at B the movable block with sheaves, which pull the chain or wire rope, M, N. There is a loss of effect, due to the altering weight of the chain, as the cage rises or falls. This difficulty may be got rid of by letting the ram move vertically, when the altering weight of the ram itself may be made to balance the altering weight of the chain. This has been done in the hoists shown in some of our wall sheets, and all such hoists as this can be readily balanced, so that the dead weights may balance at all points in the ascent and descent. They are, however, subject to the risks inseparable from the use of chains or ropes, and must be regarded as unsatisfactory for this reason. That the lifting of every load means the expenditure of the same amount of energy is not a consideration of any importance in these hotel hoists. Of course, there is a slightly greater speed when the load is small, as the water pressure is capable of lifting the heaviest probable loads; but you know enough already about water friction to see that the increase of speed is insignificant. This condition is the same for all hydraulic hoists hitherto constructed. In Fig. 12 we see a direct acting hoist. Here the ram moves, pushing the cage up directly. When the pressure of water is very considerable, say 200 lb. per square inch, and the lift is not too high, this form of hoist is good, for although rather wasteful of power, it is exceedingly simple. The press is sunk so far beneath the floor that there is room for the whole length of the ram when the cage is in its lowest position.

But you must remember that as the cage rises, the supply water pressure ought to get greater. This may be looked upon in two lights. You may either say to yourself, "As a stone is lighter when surrounded by water, so this ram is lighter when it is at the bottom, for more of it is surrounded by water in the press;" or you may put it in this form, "The pressure on the bottom of the ram must just balance the weight of ram, cage, etc., but as the bottom of the ram rises, this means that we ought to have a constant pressure at the bottom of the ram wherever it may be, and consequently a gradually increasing pressure in the cylinder everywhere as the ram rises." Now, I don't care which of these two views you take, but you must not mix them, and say that "not only does the ram get heavier, but it needs a greater pressure at its lower end as its lower end rises." This would be the same sort of a thing as saying, "John was lent by James a sixpence; James lent John a sixpence, therefore, somehow or other, a shilling has to be paid by John to James." I prefer always to say: "The ram appears to get heavier just in proportion to the amount it has been raised, and this must be balanced by increasing the pressure of the supply water."

Now, remember that our supply water in Fig. 12 is at a constant pressure, and you will see that it is quite impossible, with such a simple arrangement, to have perfect uniformity of action, although it is approximated to more and more nearly as the pressure is greater. In this kind of hoist it is usual to let the water escape from the cylinder to a discharge cistern considerably above the cylinder, so that in its descent the ram and cage may not fall too rapidly. Here, again, we have the same want of uniformity of action, since the apparent weight of the ram gets less as it falls.

The usual practice has been to nearly balance the dead weight of ram and cage by a weight, as in Fig. 11, so as not to require too high a lift in the discharge pipe, and to be so arranged that the varying weight of chain shall just balance the apparent change of the ram. Unfortunately, these chains and counterweights destroy the simplicity and absolute safety of the hydraulic hoist. If the ram were to break near its upper end, the cage would be drawn violently upward by the chain. The upper part of the ram is in tension, and the lower part in compression.

It is obvious, then, that there must, for a complete and perfect hydraulic lift, be such a regulation of the pressure of the water as it enters the cylinder of a hoist, that the only force to be overcome shall be the variable weight placed in the cage, whether that of passengers or goods, together with the necessary friction. I think that Mr. Ellington's balance hoist satisfies this condition. It can be worked with either high or low pressure water: the ram is always in compression, supporting the load, and no part of the machinery is above the cage, and there is no part of the machinery likely to break in such a way as to cause an accident.

This hydraulic balance lift is shown in Figs. 13 and 14. The hydraulic cylinder, ram, and cage are as usually made, except that the ram is somewhat smaller in diameter. Its size is determined by the strength required to carry the load, and not by the working pressure of water available. The lift cylinder is in hydraulic connection with a second and shorter cylinder, below which is a cylinder of larger diameter. There is a piston in each, connected by the rod. The capacity of the annular space, E, below the upper piston is equal to the displacement of the lift ram. The annular area of the lower piston is sufficient, when subject to the working pressure, to overcome friction and lift the net load; and the full area of the upper piston is sufficient, when subjected to the same pressure, to balance within a small amount the unalterable weight of the ram and cage.

Assuming the cage at the bottom of its stroke, the valve is opened by a man in the cage pulling on a rope, by a system of levers, and pressure water is admitted. The pressures on the two pistons cause them to descend, forcing water from the annular space to the hoist cylinder. The hoist ram ascends, and in doing so gets heavier, but the pistons are descending, and the total pressure on them is getting greater just in the same proportion. When the ram reaches the top of its stroke the valve is closed and the lift stops. Now, open the exhaust valve, which lets the water pass away from C—only from C, remember—and the weight of the ram and cage presses the water from the lift press into E, causing the pistons to rise.

To make good any possible leakage, provision is made for admitting pressure water under F, and so raising it, the lift ram being at the bottom of its stroke, that water will flow into the space.

We see that the hydraulic hoist has: 1st, The great element of safety from the breakage of chains or ropes. But, in some forms, it is not without a danger of its own—namely, the danger that when the cage is remaining caught in a fixed elevated position for a long time, the cylinder may be emptying of water through a neglect of the valves. 2d. That the expenditure of energy depends very little upon the dead load. But there is still the drawback that every load, however small, requires the same expenditure of energy as the greatest load which it can lift. This drawback is common to all hydraulic hoists such as I have been describing.

RECENT IMPORTANT ENGINEERING WORKS.*

By James Brunlees, F.R.S.E.

In considering the more important engineering works which had been lately finished, or were in process of execution, he was reminded of the small progress in the arts of construction until a recent period. In nearly all that concerned work executed in stone, wood, or earth, the constructions of the ancient engineers might be put in comparison with some of the best modern examples, and in those materials probably their work would never be surpassed. The Panama Canal, when completed, would be as important a link in water communication as the Suez Canal. But canals of great magnitude were among the earliest engineering works on record. History mentioned two at least of importance; the canal for uniting the Red Sea with the Nile, and a canal across the Isthmus of Athos, vestiges of which remained. In regard to tunneling, the ancients had not been yet outstripped. To carry off the superfluous waters of Lake Fucinus, the Emperor Claudius constructed a tunnel 38 feet high, 28 feet wide, and three miles long, chiefly through solid rock. With the exception of explosives and machine drilling, it was apparently executed much as work of that kind would be now; but those exceptions showed that it must have required vastly more labor and time. He then referred to the manner in which a passage had been opened beneath the river Euphrates, from one bank to the other, a distance of more than 180 yards. The course of the river was diverted, and a tunnel was constructed of brick, cemented inside and out with asphaltum. The walls, which were twenty bricks thick, were 12 feet high to the springing of the arch, and the width of the tunnel was 15 feet. It was on the island of Pharos, opposite Alexandria, that the first lighthouse was erected by Ptolemy, nearly three centuries before the Christian era. Winstanley's lighthouse at the Eddystone, the predecessor of the works of Smeaton and Douglas, was probably not more efficient than the Roman pharos on the heights of Dover. Even the problems regarding the disposal of sewage were attempted to be solved by ancient Rome, and dealt with by her engineers much in the same way as in the present day. A great "low level" sewer, 30 feet high by 15 feet wide, received the drainage of a network of sewers coming from the city on the hills, and delivered the accumulation into the Tiber. It was the main artery of a system of sewerage and drainage which there had been no attempt to rival until, in modern times, the London main drainage system had been carried out. Recently some of the more formidable barriers to communication were being surmounted by the introduction of steel. The bridge to be erected across the Forth, at Queensferry, was the largest ever undertaken. It would consist of two spans of 1,700 feet, two of 675 feet, fourteen of 168 feet, and six of fifty feet, with a clear headway for navigation of 150 feet above high-water of spring tides. The two large spans were composed of two cantilevers, each 675 feet long, with a central girder 350 feet long, the depth of the cantilevers being 350 feet at the piers and 50 feet in the center. To hold aloft and to maintain the immense weight of steel of which the cantilevers and girder were composed, piers would be required of corresponding magnitude. The central pier, on the island of Inchgarvie, would consist of four cylindrical masses of concrete and masonry 45 feet in diameter at the top and 70 feet at the bottom. They would be founded on rock at a depth below high water varying from 24 to 70 feet, and would be carried up to 18 feet above high water. The length of the bridge would be more than a mile, and of the viaduct approaches 2,754 feet. The contract had been left for £1,600,000.

A less remarkable work, but still one of great importance, was the new Tay bridge. This was to be erected on new foundations on the up-stream side, and as near as practicable to the site of the previous bridge. It would be 10,780 feet long, divided into eighty-five spans, of which eighty-one would be crossed with iron girders, and the remaining four would be brickwork and masonry. Of the thirteen spans over the navigable waterway two would be of 227 feet, and eleven of 245 feet each, and the height from high water to the bottom of the girders would be 77 feet. The piers would be of wrought iron plated all over, and supported on iron cylinders of suitable dimensions, sunk 20 feet into the bed of the river, and filled with concrete and brickwork. The parliamentary estimate for the work was £654,000, but the contract had been let for less than that sum. Another bridge of a similar character was that over the river Ganges at Benares. It consisted of seven large spans, each 356 feet from center to center of the piers, and nine smaller spans. The depth of the river when at the ordinary level was about 20 to 30 feet, but floods had been known to rise 50 feet higher, thus making the whole depth of water from 70 to 80 feet. The scour in the river bed, which was of sand, was very great; therefore, the foundations had to be sunk to a depth of 120 feet. The girders were of steel 25 feet apart, with a 5-foot footpath on each side.

A work of a different type was the Kinzua viaduct, across a long, narrow valley, with lofty precipitous sides, on the Bradford branch of the New York, Lake Erie, and Western Railroad. Its height was 302 feet from the bed of the stream to the rails. Its length between the abutments was 2,051 feet, divided into twenty spans of 61 feet each, and one span of 62 feet. The girders were carried by wrought iron towers or piers having a uniform width at the top of 10 feet, and a span of 38½ feet. The upper half of the piers was composed of four, and the lower of six wrought iron columns, 1 foot in diameter, braced together, and having a batter laterally of two inches per foot, so that the highest piers had a base of about 100 feet. As an additional stay against the wind, the iron shoes at the bottom of the columns were bolted through the piers, and the columns were braced together throughout their length. The East River bridge, between New York and Brooklyn, was on the suspension principle. The total length was 5,989 feet, which was divided into three spans, the land spans being 930 feet each, the river span 1,595 feet 6 inches, and its height above high water 134 feet. The width of the bridge was 85 feet, and it was intended to accommodate foot passengers, railway trains, and ordinary street traffic. The cables were four in number, each having a diameter of 15¾ inches, and were calculated to stand a strain of 12,200 tons each. There were two suspension towers, each 278 feet in height above high water, and 159 feet above the roadway. Its cost would be, in round figures, about £2,800,000, independent of the cost of land.

From the consideration of bridges, Mr. Brunlees passed to the subject of tunnels. The longest tunnel yet constructed was the St. Gothard, having a length of 14,912 meters. It was opened for traffic on the first day of 1882. The northern end was 3,638 feet, and the southern end 3,756 feet above sea-level. The sudden rise from the level of the railway proper to the mouths of the tunnel was surmounted by spiral tunnels of approach, which ran above one another on a radius of 15 chains and a gradient of 1 in 43·5. There were three of these spiral tunnels at the north, and four at the south end of the great tunnel. The Severn tunnel was the largest work of the kind in this country. It passed under the estuary about half a mile below the ferry which connected the Great Western Railway with the railways of South Wales. The total length of the tunnel was 7,942 yards, of which 2¼ miles were under the tideway. The greatest depth of water over the tunnel at high water was 96 feet, and at low water 60 feet. The tunnel passed through beds of shale and Pennant sandstone of the coal-measures, and through the nearly horizontal beds of Keuper marls, which overlay these measures. Water had been met with in all the strata, sometimes in large quantities. One spring in the millstone grit, on the land approach to the tunnel, discharged over 5,000 gallons a minute, and its sudden inroad caused a temporary stoppage of the works. The tunnel was 26 feet wide at seven feet above rail-level. It was lined with vitrified bricks, set in Portland cement, the lining being from 1 foot 10½ inches to 3 feet thick. The total cost of the tunnel would be about £1,500,000. The work of tunneling beneath the river Hudson, between New York and Jersey City, was remarkable chiefly on account of the difficult nature of the material. There were two single-line tunnels, 30 feet apart, and parallel to each other, and they were intended to bring the railway traffic of the South-West and South into the city of New York, from which that traffic was at present cut off by the Hudson. The width of the river at that point being tunneled was one mile; its greatest depth at mean low water was 62 feet. The tunnels were being driven by the pneumatic process. The Mersey Railway was intended to effect direct communication between the Lancashire and Cheshire railway systems, and included a tunnel 3,820 yards in length, between Liverpool and Birkenhead, 1,300 yards of which were under the river Mersey. The tunnel and drainage headings below it were being driven through the red sandstone formation. These headings commenced from shafts one mile apart, sunk on each side to a depth of 180 feet; they were carried on an ascending gradient to the center of the river, where they would meet the main tunnel, which was constructed on a descending gradient at the same point. Powerful pumping machinery had been erected at each side, and at Liverpool 4,500 gallons of water per minute had been raised. At Birkenhead the water had never exceeded 3,000 gallons per minute. The main tunnel was being driven from two independent shafts, and was carried forward from these landward and riverward simultaneously. It was being lined with brickwork, set in cement. The length of the railway was three miles, and its cost would be about £1,000,000.

After alluding to the proposed Channel tunnel, Mr. Brunlees referred to the Panama Canal. The project to unite the Atlantic and Pacific oceans by a canal across the narrow neck of land which joined the two American continents was a very old one. During the last century and a half many surveys had been made in different parts of the isthmus to demonstrate the practicability of the project. Several schemes resulting from independent local investigations were before the public, when Count De Lesseps succeeded in obtaining a meeting of an international congress, in Paris, in May, 1879, to select the project which might be intrusted to a public company. This congress adopted the general features of the scheme now being carried out. It was proposed to be a canal without locks, from the Atlantic to the Pacific, 73,000 meters long, 8½ meters deep, and having a minimum width at the water-line of 22 meters. The canal commenced on the Atlantic coast, at the bay of Limon, with a depth of 8½ meters, and went through the marshes of Mindi, in the direction of the river Chagres, which it joined in the vicinity of Gatun. It was then kept up near to the river, which it cut several times, and by a series of curves and straight lines reached Matachin, where it separated from the river Chagres, and continued in a southeast direction along the valley of the Obispo, a tributary of the Chagres. It then entered the valley of the Rio Grande, and in a series of straight lines and curves reached the Gulf of Panama, near the islands of Naos and Flameneo, with a depth of 7½ meters below the lowest tides. It was provided with passing places at suitable distances.

The estimated cost of the canal was £31,200,000. The canal would abridge the voyage between Europe and the western coast of America, at the equator, some 2,500 marine leagues, and considerably shorten the voyage to the eastern parts of Australia, to New Zealand, and to China and Japan.

Among works of interest for the shelter and accommodation of shipping, Mr. Brunlees drew attention to the Alexandra Dock works at Hull, and the new harbor of Port Elizabeth. The former were situated on the left foreshore of the river Humber, some distance below the town, in great part seaward of the high-water line. The sea-embankments, upward of 6,000 feet in length, had been completed, together with the cofferdam for the entrance lock, and the tidal water had been excluded from the site of the dock and quays. For the first time in carrying out works of this class, the excavations and masonry were executed, in great part, by hydraulic machinery, worked by the permanent engines of 300 horse-power. The water space of the dock would be 2,300 feet in length, and 1,000 feet in width. The total length of wharfage afforded by the walls and jetties would be 9,450 lineal feet. The harbor for Port Elizabeth, in Algoa Bay, was of a different type. It solved the problem of affording shelter for shipping from the heavy seas constantly rolling in upon the beach in that region, without obstructing the natural movement of the sand, which would speedily render any ordinary protection useless. This movement was confined to the comparatively shallow water near the shore, and was caused by heavy southeasterly seas. As a first step toward the execution of the general design, a retaining bank had been constructed along the shore at the southern end of the town, which had had the desired effect of clearing away a large quantity of the sand accumulations. From the northern end of this bank a viaduct was to run out in a northeasterly direction 3,000 feet, into 6 fathoms of water at low tide. It was to be formed of wrought-iron piles, placed in bays 30 feet apart, securely braced together, and supporting a deck of wrought-iron girders, with a plated floor carrying the road surface, on which rails would be laid

* Inaugural address recently delivered before the Institution of Civil Engineers, London.

in the usual manner and connected with the system of existing railways. The viaduct would present no obstruction to the sand-travel, and therefore cause no diminution of the depth of water. At the outer end a breakwater was to be constructed of large concrete blocks, founded on a substratum of rubble, carried down to a sufficient depth to prevent disturbance by wave-action. The cost of the work would be about £950,000.

The works for an improved supply of water for Liverpool were making rapid progress. The water was to be impounded from the watershed of the river Vyrnwy, in North Wales, a distance of 67½ miles from the Prescot reservoirs, to which it was to be brought partly by aqueduct and partly in tunnels and pipes. The area of the watershed was 17,513 acres. The upper waters of the Vyrnwy were to be impounded in the valley of the river by a dam, which would collect the waters of the river into a reservoir having an area of 1,115 acres. Manchester recently obtained powers for an additional supply of water from Thirlmere. All were agreed that a supply of pure water was one of the most important means of maintaining the health of large towns, and it had also come to be admitted that it had an important influence on their moral condition. It would be well, therefore, if London would seek to emulate the northern cities in supplying its population with pure water.

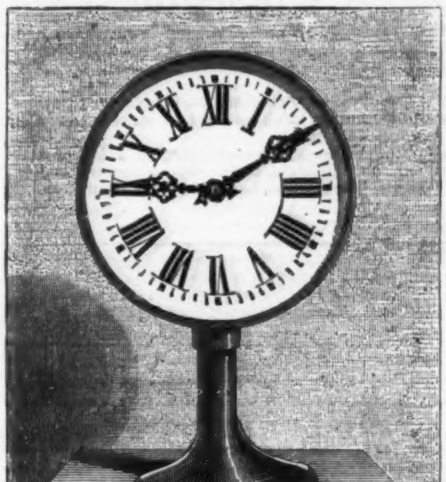
The old Eddystone Lighthouse, completed in 1759, had always been an object of peculiar interest to the nation. It was with a feeling akin to personal regret that the public learned for the first time in 1877 that Smeaton's work was doomed; but it was a source of satisfaction and consolation that nothing in the design or construction of the tower itself conduced to the necessity for replacing it; but the rock upon which it was reared had not been so enduring. The new tower was 130 feet high above high water, or 58 feet higher than the old tower, and nearly five times the quantity of stone was used in its construction. Smeaton's tower contained only four rooms; that of Sir James Douglas nine, of larger and loftier proportions. It had cost £78,000, and had been completed in three and a half years. Since the application of electric light at the South Foreland Lighthouse, in December, 1858, considerable progress had been made with all the luminaries applied to lighthouses. At the above date, the standard intensity of the first-order oil-light was 230 candle-units, and the intensity of the most powerful electric light was about 670 candle-units. Recently, at the Eddystone Lighthouse, two oil-lamps, each of 720 candle-units, had been adopted. This intensity would shortly be considerably exceeded. With electric light, a focal intensity of about 10,000 candle-units was applied at the Lizard, and arrangements were being made by the Trinity House for practically testing the merits of an electric light of 60,000 candle-units intensity. With coal-gas light great progress had been made since 1865, by Mr. John Wigham, of Dublin. In the latest development of his system four burners were employed, each of 1,250 candle-units intensity.

Mr. Brunlees then briefly referred to the want of railway communication in many productive countries. The immense population of China would derive great advantages from the construction of railways. It had been said that the objection of the Chinese proceeded chiefly from the fear of introducing foreigners in any considerable number. Chinese statesmen, even those most liberal and enlightened, at one time believed that railways were not adapted to the circumstances of China. They had recently formed a different opinion, An official memorial had been drawn up by one important government officer, and favorably reported on to the government by another high official, suggesting and recommending the construction of four important trunk lines, and no doubt if these were once executed many more would follow. In India somewhat more than 900 miles of railway were in course of construction, including three bridges of more than ordinary importance. When the works now in progress were completed, India would have nearly 12,000 miles of railway open for traffic. In New Zealand the length of railway in various stages of progress during the year ended March 31st last was 234 miles, and 1,333 miles were then open for traffic, and an additional expenditure of £1,650,000 had been ordered. In Queensland, only a few miles appeared to be under construction; but an extensive system of railways was under the consideration of the government. In South Australia considerable progress had been made in railway building, and this might also be said of Victoria and New South Wales, where there were 342 miles under construction. He regretted that the Australian colonies had not adopted the same gauge for their lines. With the disadvantages which had arisen in England, in India, and in America from a break of gauge, and from the great advantages which Western and Central Europe had derived from a uniform gauge, it might have been thought prudent on the part of the Australian colonies to have accepted the experience of older communities. In Canada, 2,910 miles of railway were under construction; and in the United States some 11,000 miles had been constructed during the last year. In the United States and in Canada the tendency was toward a uniformity of gauge.

The undue neglect of the inland navigation of this country was a subject which deserved the attention of the engineer. For coarse goods, a slower conveyance than the goods-train might be endured in consideration of its greater cheapness. But to be more extensively useful it must be something between the present speed of the canal-boat and the goods-train, with the punctuality of the latter. Mr. Brunlees then drew attention to the fact that the trained engineer was a comparatively modern creation. Until little more than a hundred years ago Great Britain contained hardly a canal or a passable high road; and two centuries ago it was necessary to send to Holland for an engineer to build a sea-wall. A Rivers Conservancy and Flood Prevention Act was greatly needed. Private interests of the most insignificant character were suffered to interfere with or prevent the execution of plans which would be of manifest advantage to large populations. To carry out any local or general public improvement, private persons must be organized into public bodies, and appeal must be made to the cumbrous and costly machinery of parliamentary legislation in every individual case. There was signs that this ancient system, suitable enough for the rate of progress of public works half a century ago, but unsuited to the rapid march of improvement in our time, would before long be modified and improved. During recent times of depression, fear had been expressed that the profession was too full, that the work of engineers had been completed. But these fears were vain. So long as capital accumulated in this country, it must be expended in some productive way at home or abroad. Judiciously planned public works were always productive, and the men who found the means would appoint the agents for carrying out the works. Not only were public works, including many new or larger harbors and docks, required at home; not only were new countries of vast extent and enormous resources being gradually laid open to the operations of the engineer, but a greater diversity of employment was offered to him. It was impossible to say to what uses the comparatively new power of electricity might be put, but it must play an important part in the social industrial economy of the age.

MATTHEY'S HOROGRAPH FOR SCHOOLS.

ONE thing worthy of remark is that a knowledge of the time of day by reading the position of the hands on the dial of a clock is acquired but slowly by most children. Whether this is due to the unequal motion of the two hands, or to the duodecimal division that they pass over, or to the Roman figures indicating such divisions, it would be impossible to say. Very frequently, very intelligent children, who understand the four rules of arithmetic, as well as music satisfactorily enough, are incapable of indicating the hour marked by the face of a watch or clock.



MATTHEY'S SCHOOL HOROGRAPH.

The sole cause of such an ignorance as this is due to the fact that an idea of the time is nowhere *taught*, although within so easy reach of children. This constitutes a regrettable deficiency in the teaching of our primary schools, and children are therefore forced to learn solitarily how to tell the time—some of them sooner, others later. And yet such a knowledge as this is just as useful as, if not more than, many other kinds, since it initiates children into an idea of the division of time and the manner in which it should be employed.

But it would be easy to supply the above mentioned deficiency if there were put into the hands of teachers some instrument of demonstration such as has been wanting up to the present time. Now, such an apparatus, fulfilling the desired end, has just been devised by Professor A. Matthey, of the Ecole d'Horlogerie of Besançon. This instrument, which its inventor designates a school horograph, consists of a clock dial held vertically on a firm support, and carrying an hour and minute hand, and a dial train. With this latter there is connected a winch by means of which the hands may be turned in one direction or the other.

By means of this arrangement it becomes easy to teach children the two characteristic divisions of a clock face, that is, its division into 12 equal parts or *hours*, and into 60 equal parts or *minutes*, while at the same time instructing them as to the value of the Roman figures used for numbering the hours. Afterward, on turning the hour hand in the desired direction by means of the winch, the teacher will direct attention to the fact that the two hands revolve in the same direction, but with different rates of speed; that while the longer hand is making an entire circuit of the dial the shorter one moves only a *twelfth* of a revolution; and that, consequently, the latter can only make an entire revolution of the dial after the longer one has made such revolution twelve times. This being understood, children will very quickly comprehend that we designate as an *hour* the time taken by the longer hand to make an entire revolution of the dial, and that this time is subdivided into sixty equal parts or *minutes*. If, on another hand, they are taught that the day consists of twenty-four hours, they will without difficulty grasp the idea that during such interval of time the shorter hand makes the revolution of the dial twice, and the longer one twenty-four times. Finally, the demonstration will be completed by placing the hands in any position whatever, and the teacher will assure himself by individual interrogatories that all the children in the class are able to indicate the entire hours by the position of the shorter hand, and the complementary minutes from the position of the longer one.

Such is, in brief, the mode of making use of Prof. Matthey's school horograph, the dimensions of which are calculated according to the size of the classes, and so that each child may clearly distinguish the divisions of the dial and the relative position of the hands upon such divisions. The apparatus is very strongly made, and is easily transportable, thus allowing of its being used to teach the time in the different classes of the same scholastic group.—*La Nature.*

NEW PROCESS OF GREENING CANNED VEGETABLES.

To give canned peas, beans, etc., a bright-green color, the French usually employ sulphate of copper in the proportion of 40 to 50 grammes to 60 liters of water for 40 liters of peas. This is about 3 grammes of copper per liter of peas. A great portion of this copper is afterward got rid of by washing; yet, nevertheless, some of the poisonous salt is necessarily absorbed by the vegetables.

Recently, Messrs. Possoz, Blardot & Co., of Paris, have devised a new process of greening, which is very simple in its application, and claimed to be absolutely harmless, and the results of which have proved very satisfactory. It is as follows:

1. *For Peas.*—Into a vessel containing, say, 80 liters of boiling water there are put 40 liters of peas, which are blanched in the usual way. After this the peas are washed with cold water, drained, and put into the boxes in which they are to be preserved, and the latter are filled with a liquid prepared as follows:

A solution is first made of white sugar and chloride of sodium in ordinary water, to which is added 20 per cent. of milk of lime. After stirring, a liter of a solution with the following composition is added: 300 to 720 grammes of solution of caustic soda of 40° Baume, and 100 to 180 grammes of crystallized sulphite of soda dissolved in 500 grammes of water.

The tin boxes should be filled as full as possible, and afterward submitted to ebullition in an ordinary digester. This operation should last from ten to fifteen minutes, according to the size of the peas, the temperature employed being from 116° to 112° C.

2. *For Beans.*—After blanching as above, the boxes are filled with the following liquid:

Clear lime water, 100 liters;
Chloride of sodium, 1 to 3 kilogrammes;
Crystallized sulphite of soda, a few grammes.

The ebullition should last from six to eight minutes at a temperature of 106° to 110° C.

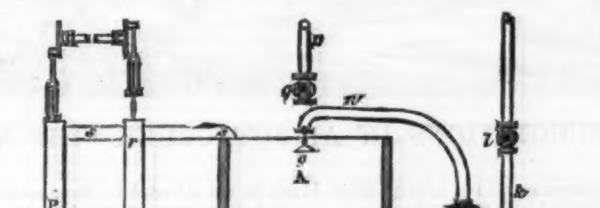
As may be seen, the substances employed in this process are absolutely innocuous, especially employed in so small a quantity.—*Annales Industrielles.*

MORRIS' BLEACHING APPARATUS.

THE apparatus shown in the accompanying cut, the invention of Mr. J. Morris, of Manchester (German patent, No. 18,685), permits of effecting, in one and the same vat, the different operations embraced in the bleaching of fabrics. The open vat, A, is provided with a perforated bottom, *b*, beneath which is disposed a pipe, *c*, having two branches, *e*, and a blow off cock, *d*. One of the branches, *e*, of the pipe leads to the reservoir, *f*, containing the bleaching liquid, and to the acid reservoir, *g*, and the other is connected with the closed vessel, *h*, which contains a steam jet apparatus, *m*.

When it is desired to use the apparatus, all the cocks are closed, and the material to be bleached is put into the vat, A. Then the cock, *q*, of the water pipe is opened; the vat is filled with water; the cock is closed; and the necessary quantity of bucking or steeping material is added. After this, the steam cock, *l*, and the cock, *z*, are opened, so that the steeping liquid, which then fills the vessel, *h*, is carried along with the steam entering through the tube, *k*, into the cone, *m*, and is thrown by the tube, *n*, and the rose, *o*, over the material to be bleached lying in the vat. When this operation is finished, the cocks, *l* and *z*, are closed and *d* is opened, in order to allow the steeping liquid to flow off.

Then the water cock, *q*, is opened in order to rinse the fabric, and afterward the cocks, *q* and *d*, are closed, and the cock, *i*, of the branch, *e*, leading to the reservoir, *f*, is opened. After this, the pump, *r*, is set in action to spread over the fabric, through the pipe, *s*, a continuous current of bleaching liquor, which finally returns to the reservoir, *f*.



MORRIS' BLEACHING APPARATUS.

When this operation has lasted sufficiently long, all the solution filling the vat is caused to flow into the reservoir, *f*, through the cock, *i*, which latter is then closed. Then the cocks, *d* and *q*, are closed; the fabric is rinsed with water; all the cocks are closed, with the exception of the one connecting the branch, *e*, with the acid reservoir, *g*; and the pump is made to act so as to spread acid over the fabric. When the acid has been in contact with the latter for a sufficient length of time, it is allowed to flow into the reservoir, *g*, the cock, *i*, is closed, and the fabric is rinsed with water.

Afterward, the blow-off cock, *d*, is closed, and a sufficient quantity of water, to which soap has been added, is let into the vat through the cock, *q*. Then the solution of soap is introduced into the vessel, *h*, by opening the cocks, *l* and *z*, and afterward forced upward into the vat by means of a jet of steam. When this soap solution has acted sufficiently long, the cocks, *l* and *z*, are closed, and *d* is opened in order to

allow it to flow from the vat. Then the fabric is again rinsed with water. These operations may, if need be, be renewed without removing the fabric from the vat. If it is not desirable to employ the vessel, *h*, the steam jet arrangement may be placed in the vat itself, beneath the perforated bottom, *b*.—*Dingler's Polytechnisches Journal.*

THE WOODLANDS, GILDERSOME, NEAR LEEDS.

THE house and premises shown in the illustration belong to Mr. Geo. Webster, manufacturer, of Gildersome and Leeds, and a member of the Leeds Town Council.

The grounds and park, which are away from the village, are 23 acres in extent, falling gradually to the south, which is bounded by a small run of water and a wood behind it.

The house has dining-room (24 feet by 16 feet 6 inches), hall (10 feet wide), drawing and breakfast rooms, front and back kitchens, pantries, lavatory, etc., on the ground-floor. On the chamber and attic floors there are ten good bedrooms, closet, w. c., rooms for bath and lavatory, which is fitted up with the ordinary slipper bath for hot and cold water, steam bath, douche bath, and circular-needle bath. The room has a fire-place, and in addition has a small heating apparatus for winter, supplied from the kitchen fire.

The material used for external walls is the best Delph stone all round, with hard white ashlar dressings. Pitch pine is used extensively in the inside, and the whole of the woodwork in the dining-room is in solid mahogany, French polished and picked out in black; and the suit of furniture for this room is in mahogany to match, and of the same period as the house, specially designed by Mr. Charles Mills, of Bradford. All the reception-rooms have ceilings divided into small panels and well filled with ornament.

The outbuildings comprise stable, loose box, harness-room, coach-house, wash-house, lodge for coachman, garden-house, conveniences, billiard-room, 32 feet 6 inches by 18 feet, and 13 feet high. The court-yard of house and stable yard are quite separate, and the latter cannot be seen at all from the kitchen.

The vineries are 120 feet long in one line of buildings, being divided internally into four 30-foot houses, specially arranged for early and late grapes. The other greenhouse buildings are about 60 feet long. One peculiarity of this horticultural scheme is that the firing-shed is 100 yards or more away from the glass, and the pipes are laid under ground.

The grounds are just about on the point of completion, although Mr. Webster has been living in the house over twelve months.

The works have been carried out from the designs and under the supervision of Mr. W. Hanstock, A.R.I.B.A., of Batley, by local builders.—*The Architect.*

SUGGESTIONS IN ARCHITECTURE.—THE WOODLANDS, GILDERSOME, LEEDS.

THE *Photo. News* says: A new photo-electric battery has been constructed by M. Saur. It consists of a square earthenware vessel containing a solution of 15 parts sea salt, 7 parts sulphate of copper, and 100 parts water. A porous pot containing mercury is put into this solution. One of the electrodes, of platinum, is plunged into the mercury; the other, consisting of sulphide of silver, is dipped into the solution of salt. The battery is placed in a box screened from the light. By putting a galvanometer in circuit, the effect of light on the battery is at once detected, a cloud passing over the sun immediately influencing the current.

ENLARGEMENTS ON GELATINE PLATES.

RESPECTING enlargements on gelatine plates, we hear but little, and I fear the capabilities of the process in this direction are but very little known. For enlarging I have tried every known process, both wet and dry, and for excellence of result there is nothing to equal the quality given if the enlarged negative be made on a gelatine plate. I have lately been making some negatives, and the resulting prints have been considered as taken from negatives direct. Some of the enlargements have been five and six diameters. One great feature is that this process does not exaggerate the high lights, as is very often the case if the wet collodion and nitrate of silver bath process be used.

A day or two since I had to make an enlargement from a quarter-plate negative of a white Pomeranian dog. Being all white it was a very difficult subject. I tried my favorite method (collodio-bromide emulsion), but having to enlarge it up to five diameters it was rather coarse, and the detail in many parts of the white hair appeared as if all matted together. At last I tried gelatine, and by working very carefully I got a splendid result, every detail being perfect, as in the original small negative. Without any retouching it gave a print better than the small negative was capable of producing.

I use an ordinary room, the camera being fixed in a light-tight window shutter, with an upright easel to carry the plates and focusing screen.

In using the gelatine process for enlarging, I also make the transparency on a gelatine plate. In making the transparency I use the best of glass, free from specks and striæ. If this be not attended to, these specks enlarge up and show painfully in the enlarged negative

In making a transparency on a gelatine plate I have heard a great many speak of the difficulty in exposing correctly. Some will recommend to expose by lamp or gas light at a certain distance. I do neither. I expose by diffused daylight without the least difficulty, and with almost a certainty in regulating the exposure, which takes from one to two minutes, according to the intensity of the original negative. I have no doubt the length of exposure will startle a great many, but I do it in this way: Presuming I have to enlarge from a quarter-plate negative, I use an ordinary portable printing-frame as in general use for that size of negative, without a plate glass bed plate. I place a gelatine plate in contact with the negative, put in the back, and close the bars over the springs in the usual way. Now for this frame I provide myself with a loose fitting deal box, like an ordinary fig box lid, which is glazed with a piece of *ruby glass*, the glass fitting down on to the face of the printing frame. I place the printing-frame therein, fix on the lid, open either the dark room window or the door, and give the exposure required. After one or two trials there will not be the slightest difficulty. "and that is," as Dr. Lynn says, "how it is done." Nothing can be more simple. If the original negative be very dense, a deep orange glass cover can be used; but in my own practice I find the ruby to suit my purpose admirably.

Sometimes I make the transparency from much larger negatives than quarter-plate. In my dark room I use orange over ruby in the window. I formerly removed the orange glass and put the frame close to the ruby glass and exposed that way; but the box is by far the better way to work. It would be very unsafe to take the printing-frame out into the light with merely a piece of ruby glass over it, as the light would be sure to get to the edges of the plate and spoil it, the plates being so very sensitive.

If a large printing-frame be used with a bed-plate larger than the negative, a mask requires to be made for the negative. It is easily done by placing the negative on a piece of cardboard, marking round it, and cutting the piece out the size of the negative—just so as to cause the negative to fit in tightly. Of course the cardboard must not be thicker than the negative. This cardboard mask prevents the light from impinging on the edge of the glass and causing a reduction all around. For making the transparency I generally use a plate the next size larger than required, so that in enlarging none of the original is lost, and by that means works right up to the edges. It does not matter how thin the original negative is, for by using the ruby glass in the way described all difficulty is overcome.

Now, having secured a good transparency, possessing only the extreme high lights—bare glass or nearly so—and the extreme depth of shadow dense, with gradations between the two, the next thing is to make the enlarged negative. I need not say that every precaution must be taken to see that no light enters the room through any cracks; if so, all labor is in vain. I generally carry my prepared plate from the dark room to the enlarging room in a large flat box well shielded from the light, and after it has been exposed I return it to the shield and take it to the dark room for developing. In making the enlarged negative, the flattest of glass must be used. The ordinary sheet glass as used for collodion will not do; for large sizes patent plate is far the best, and saves much trouble. When using large plates to get the correct exposure, it is best to expose a small one on part of the image—say a half plate, for instance—and when the correct exposure is known, there is not the slightest fear. To spoil a large plate becomes rather expensive, especially to those who purchase plates. I make my own, and can pretty well judge by practice the correct exposure.

There is one thing that must be borne in mind in enlarging, and that is, that when using small stops the light is very weak and poor, which is very much against obtaining sufficient intensity, but that can also be very easily overcome by adding certain substances to the developer which favor intensity. My favorite is grape sugar in solution. There are several others, such as ordinary loaf sugar, treacle, glycerine, tannin, ale, and many of a similar character.

A large quantity of developer has to be used for these large plates, as they all have to be developed in a tray. I find the best trays are those made with a wooden frame and a glass bottom. They can be made by an ordinary carpenter.

The worst that can be said of the substances added to the developer to promote density is that they cause bubbles. If not closely watched, these adhere to the film, and as a rule, they attach themselves just where they spoil the negative. A flat camel's hair brush I find the best for their removal by gently passing it over them. I prefer to keep the dish in gentle motion, so as not to let the developer rest.

In making large negatives I prefer to use sulphite of soda if the plates will bear it—that is, if they do not give green fog—as the developing has to be prolonged; and it is very important to keep the developer clean, as it is rather too expensive, when such a quantity has to be used, to throw it away and make up a fresh lot. After the plate has been well washed from the developer, I think the safest plan is to put it into the alum bath and prevent blistering, especially if much ammonia has been used and the plate forced. I always use it

to save risk; and it is very important that the plate be freed from the alum before it goes into the hyposulphite of soda fixing bath, for if any alum be about the plate in patches, the plate refuses to clear.

After the plate has been well washed from the hypo, I let it soak in running water for an hour or so, and then pass it through a clearing bath of alum and citric acid, or, better still—

Alum (saturated solution)............9 ounces.
Hydrochloric acid.................. 1 ounce.

It takes the whole of the yellow color out of the film and leaves the negative more of a neutral tint, so that one can judge of its printing qualities. I have not yet tried sulphuric acid instead of the hydrochloric, but hope to do so. I saw it recommended some short time since—just simply about one ounce to a quart of water. I should think that if used in conjunction with alum it would be better.

An enlarged gelatine negative has a very peculiar look about it. Instead of any coarseness, the deposit, if I may so call it, is a very fine stipple, which adds to the beauty of the print and gives it a little grain; for without this grain or stipple the effect would be lost. I have been constantly asked whether I make lantern slides by this process. For such purpose I find the color very much against it; that, to my mind, is the only drawback. I still use my favorite collodio-bromo-chloride emulsion, of which I hope shortly to give full details, with some very important modifications, which much simplifies the process altogether, and produces the most perfect results.—*Wm. Brooks, in Br. Jour. of Photo.*

REVERSED NEGATIVES BY CONTACT PRINTING.

MAJOR J. WATERHOUSE, in *Photo. News*, says: Reversed negatives may be obtained by contact printing on a dry collodio-bromide plate. After exposure to light in the printing frame, the plate is developed, as usual, with alkaline pyrogallic, the development being pushed till deposited silver is apparent in the deepest shades at the back of the plate. After development the plate is washed with water, and a mixture of equal parts of nitric acid and water is poured over it. This dissolves the reduced silver in the exposed parts of the film, leaving a negative image formed of silver bromide in the unexposed parts. The plate is then well washed with water, followed by a very dilute solution of ammonia to neutralize any acid remaining. After another thorough washing, the plate is again exposed to light, and developed, as before, with the alkaline developer, which produces a negative image. If too weak, the image may be intensified in the same way as an ordinary wet collodion negative.

Mr. Bolas has published a method of obtaining reversed negatives by contact printing applicable to gelatino-bromide dry plates, and results I have seen by it are exceedingly good.

A gelatino-bromide plate is soaked for a few minutes in a four per cent. solution of bichromate of potash, and after this it is rinsed for a few seconds in a bath composed of equal volumes of alcohol and water. On removal from this it is laid down on its back, and the moisture blotted off with clean blotting paper, the paper being pressed gently into contact with the plate by means of a cloth. The paper is removed, and the plate is dried in a warmish place. When dry, the plate is exposed to light under the negative to be reproduced, giving the same exposure as one would give a carbon print in the same light. After exposure, a delicate positive impression is visible on the exposed surface. The plate is first soaked in several changes of cold water, in order to remove the excess of bichromate of of potash; and when this is done, the plate is developed with any suitable developer, preferably with pyrogallic acid and ammonia.

Under the action of the developer, the nature of the picture rapidly changes, the light parts becoming dark and opaque, while the parts already tinted by the action of light either become actually clearer, or appear to be so by contrast. The positive, having been converted into a sufficiently dense negative, is rinsed with water, and fixed with hyposulphite in the usual manner.

Captain Biny, of the French Engineers, has published a somewhat similar method.

A gelatino-bromide plate is immersed for ten minutes in a four per cent. solution of bichromate of potash, and allowed to dry. When quite dry, it is exposed in a pressure frame below the negative to be reproduced. The plate is then taken into the dark room, and immersed in water to remove the bichromate. It is next rinsed in two waters, and, then being placed on the black ground of the bath, it is exposed to diffuse light for a few seconds. The plate is then developed with the ordinary ferrous oxalate developer, when the image will become visible either as a negative or a positive, according as the original from which the copy has been taken is one or the other. It is then fixed in the usual way. In order to prevent stripping of the film, it is a good precaution to expose the back of the film to the light, either before exposing it in the printing frame, or afterward.

PHOTOGRAPHING MACHINERY.

WHEN a manufacturer has a piece of machinery photographed, it is usually done for ulterior purposes—either to show the capabilities of his establishment, or to enable him to obtain further orders for similar or a like type of goods; and as many of our readers are doubtless called upon at one time or another to execute such work, a few hints on the subject may be both useful and acceptable.

No apparatus is required beyond that needed for ordinary out door requirements; but a most essential point is that the camera should be supplied with a double swing-back, to the usefulness of which we shall presently allude.

We have just said that the person who commissions the photographer in such cases usually does so for his own ends. One of our contributors once described how an inventor was so bent upon securing a view of an engine of his invention that he ordered a portion of a wall of a building to be pulled down to enable a photograph to be taken; on similar grounds it will not be, as a rule, a difficult matter to have carried out the one most important requirement of all to secure a good result, and that is the special painting of the machine. A piece of machinery—be it locomotive, stationary engine, or any kind whatever—is, when ready to leave the manufacturer's hands or fitted up at its final destination, in the very worst possible state for being photographed. The glossy paint (usually of the most non-actinic color) will not give a smooth effect, and if the machine be one embracing raw castings, the effect will be very objectionable. Therefore, the photographer's first thought must be to have it specially painted; and for the reason we have noted this will, as a rule, not be difficult if it be pointed out that to obtain the best results no other mode is available. The paint to employ should be a simple mixture of black and white to about what would be called a "pale slate color;" and, further, it must not be ordinary oil color, but something of the kind called "flatting" by the painters. Ordinary white lead darkened with black, and made up with turpentine with the smallest quantity of oil, or japanner's gold size, may be used as flatting. It is to be understood that the more matte or dead the paint dries the better will it hide any inequality in the surface of any large mass.

In cases where a machine is already *in situ*, and perhaps in work, it may be impossible to do this, but a temporary paint may be made by mixing whiting and lampblack with beer, adding a little crude ox-gall to make it "lie." This paint can afterward be easily mopped off.

With regard to focusing the image, the operator will frequently find the greatest difficulty in getting a proper standpoint; either there is scarcely sufficient space to retire far enough from the object, or it is too high or too low. He will, therefore, need a good assortment of lenses of various foci to meet the former conditions, and to be expert in the use of the swing-back to get rid of the difficulties involved in the latter. An engine or other piece of machinery with columns or any parallel vertical lines must not be represented with converging perpendiculars, or the photograph would be rejected incontinently; hence a lens embracing a wide angle will often be needed, with also the utmost facilities for raising or lowering the camera front. It will be remembered that the rule for using the swing-back to avoid converging perpendiculars is to keep the focusing-screen always vertical whatever the slant of the camera.

The side swing will be found most useful (as indeed will, also, where permissible, the upright swing) for assisting to bring portions of a machine into focus which, with the close quarters frequently necessary, would be difficult to focus without the use of a very small stop. We need not say that for this work, where every detail is required to be of the sharpest, the smaller the stop the better, though in practice it will be found that the conditions of light will often be such that a very small stop cannot be used. The photographer must then average his conditions in the best manner he can.

A slight scrutiny will generally enable the photographer to notice any important part that receives less light than another. The use of a reflector made of white paper (there is usually plenty of paper, and of drawing-boards to fasten it to, in machine works) will greatly improve definition there, and sometimes a sheet may be placed behind any aperture to show its outline, if the background should be dark.

In focusing, many important points may be quite invisible on the screen. To see them it will only be necessary to attach a piece of white paper. We saw a photograph once where a pocket handkerchief had been used, and the operator forgot to remove it! *Verbum sat.* Some photographers even employ a lighted taper or candle.

Finally, we would most particularly advise that, whenever it is possible, a standpoint should be avoided—when photographing in the interior of a works—that would give a window as a background. With dry plates halation would be a certain result, and whenever such conditions cannot be escaped from, the plate must be backed in a most efficient manner.—*British Journal of Photography.*

MANUFACTURE OF PHOTO. PLATES.

MACHINE coating is by no means so commonly resorted to as hand coating, the reason being, we believe, that most have found it difficult to give a sufficiently thick film when using machinery. We know, however, of several extensive manufacturers who do at least a great part of their coating by machinery, and at least one who does no hand coating at all.

Some time ago we described Mr. Swan's coating machine in these columns. It is peculiar in this, that the plates are coated face upward. So far as we know, it is the only machine in which this is the case. Briefly, Mr. Swan's arrangement is as follows. A continuous band of cloth is kept passing through a trough of warm emulsion. The band is guided by rollers, so that it passes under the level of this trough, and is caused to bear upon the upper surface of plates which are kept moving on another continuous band under the trough. The machine which is probably most in use is Eastman's. We are able, by the kindness of Mr. Samuel Fry, to describe the manner in which this machine is applied to the coating of plates in his factory, where work is carried on on a very large scale.

The greater part of the floor space of a large room is taken up by an oblong table with a level slate top. Along one side of this leveling table sit a row of girls, each of whom has opposite her one of Eastman's machines.

These are exceedingly simple, both in construction and action. The machine consists in an India-rubber roller, about two feet long and a couple of inches in diameter. This is so fitted that it may revolve on a horizontal axis, its lower surface dipping in a trough of emulsion, which is surrounded by a water jacket to keep up the temperature. The rotary motion is rapid, apparently about as quick as that given to a turning lathe for working hard wood, and is given in the same manner as in the case of a foot lathe; that is, by a treadle, flywheel with cranked axle, and a small pulley on the spindle of the roller. The direction of the motion is the same as in a lathe; that is to say, the top part of the roller is continually moving toward the operator. Of course the revolving roller carries with it a film of emulsion.

Each operator sits in front of a machine. She has at her left hand side a pile of the plates to be coated and on her knees keeps a cloth. A plate is lifted from the pile by the right hand by means of a pneumatic holder, and is passed rapidly over the roller, the motion of the plate being toward the advancing film of emulsion. A single drop of emulsion generally runs on to the back of the plate when it is being turned from face downward to face upward. This is wiped off on the cloth which the operator keeps on her lap. The plate is rapidly rocked for about a second, when it is deposited on the level table, and slid over to the other side, when, after it has laid for a few seconds to set, it is examined, and if found satisfactory is racked for drying. If any inequality of coating or other defect is noticed, the plate is put on one side, and the film is at once scraped off, to be mixed with the other emulsion.

The process is performed with extreme rapidity; and although the skill required is not so great as for rapid hand coating, yet there is evidently considerable knack in working quickly. The film given is—except in the case of an occasional plate, which, as mentioned, is at once rejected—absolutely even, and is as thick as there is any necessity for.

In machine coating, as in coating by hand, much depends on the method of cleaning the glass, and on the emulsion used. The glass must be thoroughly polished, and the emulsion must be of the nature which will flow well, and must, moreover, not be so transparent as to require a very thick coating of the plates, because in the case of machine coating, especially where the plates are held face downward, the limit of quantity which can be made to adhere to the glass is sooner reached than in hand coating. In fact we believe that many who have tried machine coating have given it up because they found it impossible to get films thick enough; the fault in reality, probably, being more in the emulsion than in the machine.

It is impossible to coat with a machine at quite so low a temperature as can be done by hand. Some imagine that advantage is to be gained by coating at a temperature only just over the melting point of the emulsion; and certainly with some emulsions this holds true, as a matte surface is gained when low temperature coating is resorted to, while the so objectionable glazed surface results from a high temperature. This is to a certain extent true of all emulsions, but the limits of temperature vary much. Thus, apart from treatment, if an emulsion contains the proportions of constituents mentioned in our last article on plate coating, a glazed surface or film will not result till a comparatively high temperature is reached, probably about 150° Fahr.

The objections to *too* high a temperature are always great. Besides the glossy surface mentioned, there is difficulty in getting enough emulsion to remain on the plate, whether hand or machine coating be in use. In the case of hand coating, a very hot emulsion darts over the edge of the plate the moment it is poured on; in machine coating the result is a thin and uneven coating.

While on the subject of machinery for facilitating coating of plates, we must not omit mention of racking machines. These are constructed to do away with the labor of placing the plates in racks, and also of the possible danger to the films which there must always be when they pass through the hands of an additional operator.

Mr. W. Cobb, we believe, constructed the first racking machine. His racks were constructed of metal pegs let into a base board, so that when the latter was vertical the pegs were horizontal, and a plate laid on them would remain in a horizontal position till the film was set. By a motion of a treadle each plate as it is coated is pushed on to a couple of pegs of this rack; the rack is then raised an inch or two, when another couple of pegs are brought into position for another plate.

Mr. A. Cowan improved on this machine by the simple device of causing the plates to travel along a distance of ten or twelve feet on parallel horizontal rails. By this means the films, by the time they reach the racks, are set, and consequently it is not necessary to have the racks with absolutely horizontal pegs. We illustrated and described Mr. Cobb's machine as modified by Mr. Cowan in the *News* some time ago. It is applicable either to hand or machine coating.—*Photo. News.*

LONG-DISTANCE TELEPHONY AND BENNETT'S TELEPHONIC TRANSLATORS.

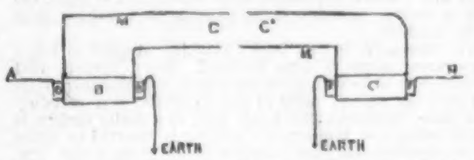
SHORTLY after the Postmaster-General had won his famous test case against the United Telephone Company, licenses were granted to the various companies throughout the United Kingdom to open local exchanges, but the privilege of joining the systems of two or more different towns was absolutely denied them, however important or desirable communication between them might chance to be from a commercial point of view.

The exchanges opened by the National Telephone Company in Glasgow, Greenock, Dumbarton, Paisley, Hamilton, and Coatbridge may be taken as an illustration of the difficulty. The business relations between these centers are of the most intimate nature, it being not uncommon for one firm to possess branch works or offices in two or more of them, and daily customers in all, and yet the company was not permitted to erect anything but local exchange lines.

But, after some negotiation, the Post-office consented to provide trunk wires on their own poles between the various exchanges, stipulating that a separate trunk wire should be erected for every eight subscribers desirous of availing themselves of the privilege, and for every trunk wire the company should pay the government an annual rental of £320 between Glasgow and Greenock; £104 between Glasgow and Paisley; £128 between Glasgow and Hamilton, and £120 between Glasgow and Coatbridge. Subsequently, a trunk wire was projected between Glasgow and Edinburgh, for which the government tax was fixed at £560 per annum. Similar arrangements were made for Leeds, Bradford, Huddersfield, Birmingham, Wolverhampton, and other important towns, and, notwithstanding the heavy rates which the government tax rendered necessary, amounting, in the case of Edinburgh, to no less than £110 per annum for each subscriber, the leading manufacturers and merchants were not slow in taking advantage of the opportunity of obtaining free communication with their distant works and customers. But now arose a difficulty which, perhaps, may have been overlooked by the Post-office electricians, and certainly by the officials of the National Telephone Company, by whom the negotiations were conducted. Being erected on the same poles as the ordinary telegraph wires, the new trunk lines would obviously be greatly affected by induction. This was recognized, and it was agreed to run metallic circuits on the principle first suggested by Professor Hughes, and first given practical effect to by Messrs. Moseley and Sons, of Manchester. This plan was, of course, known to be effective in neutralizing the effects of induction from neighboring telegraph wires, but until the contract with the Post-office was nearly, if not quite completed, no person had considered how the extremities of the metallic loops forming the trunk lines were to be connected, when required, to the subscribers' single local wires.

Putting the metallic loop to earth anywhere would be to destroy its efficacy, while it was quite impossible, on the score of expense, to run metallic loops for the local subscribers, as that would mean doubling the company's already crowded systems. When the terms of the contract came to the knowledge of Mr. Alfred R. Bennett, engineer to Messrs. D. and G. Graham, the National Telephone Company's engineers and contractors for the Glasgow district, he pointed out the hitherto unseen rock ahead, and was requested to devise a means of overcoming the difficulty. In May, 1881, Mr. Bennett began to experiment, and, after trying several plans, patented the only one which promised success. This consisted of a system of induction coils of peculiar construction, arranged to repeat or translate the telephonic pulsations to and from the metallic loop without

putting it to earth at any point. Having induced currents of small quantity to deal with, it was evident that coils having primaries of the usual thick wire and small resistance would not answer. Coils with primaries and secondaries of equal gauge and resistance were therefore tried, but it was afterward proved that the best results were obtained from coils having a resistance ratio of 1 to 2·6. The connection between the metallic circuit and the single wires may be understood from the annexed figure:



A leads to switchboard and subscribers. B indicates Glasgow Exchange. C C' is a metallic loop 50 miles long. G indicates Greenock Exchange. H leads to switchboards and subscribers.

One of the coils of the translator at the Glasgow Exchange is connected by means of the metallic trunk loop, which in this case has a total length of 50 miles, with one of the coils of the translator at the Greenock Exchange. When a Glasgow subscriber wishes to speak to a Greenock subscriber, their respective single wires are joined to earth through the switch-boards and the disengaged coils of the translators. The speaking is then transmitted in the following manner:

(1) The current arriving at the Glasgow Exchange from the first subscriber's wire, A, passes through the coil, D D, of the translator to earth; and,

(2) Induces in the other coil, B, of the translator similar currents, which pass over one wire of the metallic loop through the coil, G, of the Greenock translator, and back to Glasgow by the other wire of the loop; and,

(3) Induces similar currents in the other coil, F F, of the Greenock translator, which pass away to the second subscriber's wire, H, *via* the switch board, and to earth through his telephone, the other end of the coil, F F, being to earth at the exchange.

M and M' are magneto-electric calls and bells, inserted one in each wire of the metallic loop, for the purpose of enabling the exchanges to attract each other's attention.

Although some diminution in the loudness of the speaking results from the double transfer by induction to and from the metallic loop, this can be compensated for by speaking closer to the transmitter, or more distinctly than is usual on local lines; or by using two or more cells joined for quantity on the transmitter instead of the ordinary single cell. Curious features of this apparatus are that the current is changed no less than four times between the speaker's transmitter and the listener's telephone, and that induction is successfully used in one form to combat the evil effects of the same phenomenon in another. In the Glasgow district, the invention, which is now the property of the Electromotive Force Company (limited), has been working successfully for about nine months, and for a shorter period in Staffordshire, Warwickshire, and Yorkshire. Its sphere of usefulness will, doubtless, enlarge as telephonic intercommunication between distant towns becomes more common.—*The Electrician.*

ON THE THERMIC PHENOMENA OF THE INDUCTION SPARK.

By A. NACCARI.

A BRASS tube of 12 centimeters in diameter, introduced into the middle aperture of a Woolf's bottle, was closed below hemispherically; it contained 8 grms. of water and a thermometer. In a lateral aperture of the Woolf's bottle a wire was fitted by means of a cork, and terminated in a brass ball, 10·1 millimeters in diameter below the tube, and at a distance of 3·5 millimeters from its lowest part.

The Woolf's bottle was exhausted and the heating of the water in the tube, on passing the currents of an inductorium in one or the other direction, was observed by means of the intercalation of a thermometer.

The circuit had to be interrupted by an extent of air 2 mm. in length, in order that the discharges might be entirely directed in one way; otherwise the results would have been irregular.

With the decrease of pressure the heating of both electrodes diminished.

The proportion of the heating of the negative and the positive electrode increases thereby from 3 at the pressure of the atmosphere to 4 at a pressure of 11 millimeters of mercury. If an interruption is present in air sufficiently rarefied, the indirect induction current antagonistic to the inducing current preponderates, if the electromotive force is sufficiently great.

In further experiments at the pressure of the atmosphere, a condenser was introduced into the circuit. For this purpose the positive pole of the inductorium was connected with a ball, opposite which was placed another ball, connected with the coating of a condenser (a Leyden battery). The same coating was connected with one electrode, a hollow brass ball, 5 centimeters in diameter, filled with petroleum; while the other coating was in communication, by means of the galvanometer, with the other similar electrode, and the other pole of the inductorium.

In these experiments the proportion of the heating of the negative and positive electrode diminished with the increasing capacity of the condenser down to 1, after which changes had no effect. Up to a certain capacity the heat produced in both electrodes is differently distributed. If the capacity is greater, the heat increases to a maximum and then declines again.

Finally, into a thin glass globe, with two small tubulures, there were introduced two copper wires 3 millimeters in thickness, the very even end surfaces of which were at the distance of 7·8 millimeters from each other. The ball was placed in a calorimeter full of water (75 cubic centimeters), through which the copper wires are led, insulated. As the intensity of the current increased, the potential difference between the electrodes, derived from the heating, decreased. A condenser introduced into the circuit reduces the mean potential difference of the electrodes the less as the capacity is greater. This potential difference derived from the heating is very much smaller than that recognized by Thomson and others at the commencement of the discharge.—*Wiedemann's Beiblätter.*

THE MAGNETIC MUSIC TEACHER.

THIS small apparatus for teaching has appeared to us to be very ingenious, very practical and well worthy of being called attention to. It consists of a box, which, in Fig. 1, is represented one-half actual size. When the cover is opened, there is seen glued to a pane of glass a diagram which we reproduce in Fig. 2. A small movable cardboard disk in the center carries the questions connected with the teaching of music: "How many notes are there?" "What is an octave?" etc. When it is desired to have an answer to the question, the disk is revolved so that the question is at the upper extremity of the diagram. For example, we ask, "How many notes are there?" and we revolve the disk until it has the position shown in Fig. 2. This done, we at once see under the glass a small hand-shaped cardboard index point out the answer, "seven."

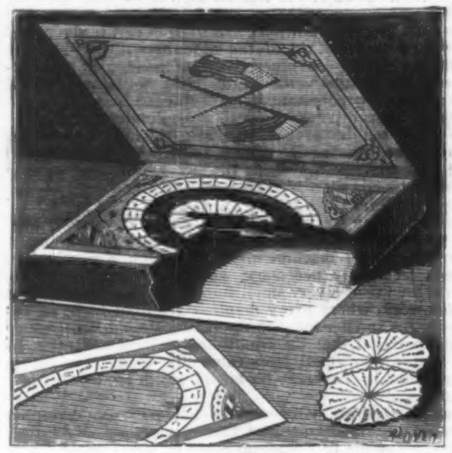


FIG. 1.—THE MAGNETIC MUSIC TEACHER.

If we place the question "What is an octave?" at the top of the diagram, the hand will again revolve and point out the answer, "The interval between a note and its most perfect concord."

This curious apparatus operates as follows: The hand-shaped index is fixed to the extremity of a small magnetized needle which is pivoted like the needle of a compass. The movable disk that carries the questions contains internally another magnetized needle. When this disk is revolved, the magnetized needle of the box follows it in its rotation, and the two needles tend to place themselves parallel with each other, their poles of contrary name superposed. This principle being admitted, the manufacturer has combined his diagrams, that is to say, the external series of answers and the inner series of questions, so that the first shall correspond with the second through the position of the two magnetized needles.

There are two sets of questions and two of answers for the instrument, but there might be several.

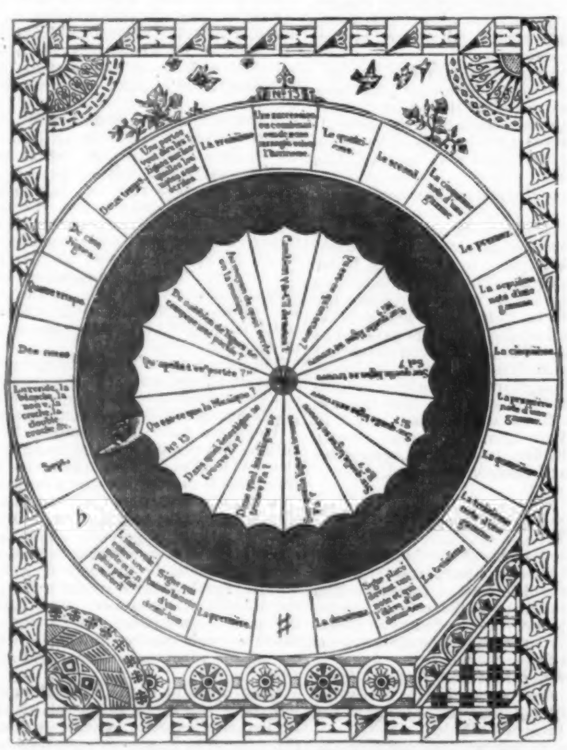


FIG. 2.—DIAGRAM OF QUESTIONS AND ANSWERS.

This system might be extended to any other branch of teaching than that of music. It might, for example, serve as a basis for a multiplication table, for questions in geography, etc. The idea, in fact, is an original one, capable of numerous applications.—*La Nature.*

THERE seems to be a general opinion among naval engineers, that no iron passenger steamship can be said to be constructed upon the best design, which insures safety in case of collision or running upon a rock, unless she is provided with a double bottom. But the space which is thus taken up is under existing laws measured as tonnage carrying area, and there is practically a premium for the neglect of an essential means of security. Few shipowners like to be taxed for a costly effort in itself to preserve the lives of others.

LITHIUM.

DR. TOMMASI concludes from recent experiments that the atomic weight of lithium ought to be 14 instead of 7, at least in its salts. In *Les Mondes* of January 18, 1883 (p. 51), he acknowledges that its specific heat, which is 0·9408, points very clearly to 7 as the atomic weight of the metal, and also that lithium in a free state resembles one of the alkaline metals. But its salts, he continues, have no analogy to the salts of potassium or sodium, while, on the contrary, they closely resemble the salts of the dyad metals of the alkaline earths, and particularly the compounds of magnesium.

One of the most characteristic properties of the alkalies is that their sulphates unite with the sulphate of alumina to form *alums*; but the sulphate of lithium does not form an alum. The alkalies form bisulphates, as well as neutral sulphates, but lithium does not form a bisulphate. The alkaline carbonates are very soluble in water, while the carbonate of lithium is nearly insoluble. [Carbonate of lithium dissolves in 100 times its weight of cold water.] The alkalies form anhydrous chlorides, which are not deliquescent, and can be melted without decomposition; this is not true of the chloride of lithium, which is highly deliquescent, and readily decomposes if heated in contact with air.

On comparing the compounds of magnesium with those of lithium, the resemblance is so striking that I am persuaded, he says, that, ignoring the specific heat of lithium, there could be no doubt that the atomic weight of this metal ought to be doubled, and its salts represented by formulæ analogous to those of the dyad metals. Consequently there is nothing to prevent our doubling its atomic weight, except the specific heat. And can we not admit, for the sake of hypothesis, that lithium, when in combination, has an atomic weight twice as large as it possesses in the free state?

On this supposition the chloride, nitrate, and sulphate of lithium would have the following formulæ respectively:

$$LiCl_2;\ Li(NO_3)_2;\ LiSO_4.$$

These new formulæ show the great resemblance of lithium and magnesium, the corresponding salts of which are written:

$$MgCl_2;\ Mg(NO_3)_2;\ MgSO_4.$$

Under our hypothesis the metal lithium will continue to have the atomic weight of 7, and it will only be in the compounds that it will have an atomic weight of 14.

There is nothing impossible in the same element having two different atomic weights according as it is free or combined, for at least one other metal shows the same anomaly, viz., aluminum. For example, the atomic weight of this metal, deduced from its specific heat, is 27·5, but in its compounds it always has double this atomic weight, which is expressed by writing Al_2 in formulæ. Thus we have Al_2R_6, Al_2R_3, etc. (R representing a haloid or acid radical), or what would be better, as I suggested some years ago, the formulæ AlR_6, AlR_3, by doubling the atomic weights of aluminum. The very smallest quantity of aluminum that is able to enter into a compound is 55, never 27·5, consequently 55 really represents the atomic weight of aluminum, not in a free state but in combination.

A few years ago I proposed to verify this double atomic weight of lithium in its compounds by determining the vapor density of a volatile compound of lithium; for example, lithium ethyl, but to my great regret I have been unable to undertake this very expensive experiment.

Some recent experiments of F. M. Raoult on the congealing of different saline solutions, have induced me to put forth at this time my hypothesis on the atomic weight of lithium. Raoult believes that he has discovered the following law:

"One molecule of any compound, when dissolved in 100 molecules of any unlike liquid, lowers the freezing point of that liquid by a (nearly) constant quantity, which is in the vicinity of 0·62° Cent. (1·12° Fahr.)."

If this law be accepted as true, nothing is easier than to accept or reject my hypothesis of doubling the atomic weight of lithium in compounds. For this purpose it is only necessary to dissolve 1 molecule of chloride of lithium (42·5 grammes) in 100 molecules (1,800 grammes) of water and ascertain the melting point of this solution. If my hypothesis is true, we ought to find that this quantity of chloride of lithium would lower the freezing point only 0·31°, which

would prove that 42 [illegible] represent the true molecular weight of chloride of lithium, and consequently we ought to double the old formulæ for lithium compounds to make them agree with the molecular formulæ of other chemical compounds.

As it is necessary that these experiments be made with extreme care, by skillful manipulators, with very delicate apparatus, Tommasi requests Raoult to verify the correctness of his (Tommasi's) hypothesis "on the doubling of the atomic weight of lithium as controlled by his (Raoult's) beautiful law on the freezing point of saline solutions."

As two important points will be set at rest by this experiment, we anticipate that M. Raoult will hasten to comply with the request of M. Tommasi.

THE CHEMISTRY OF HOPS.

By R. L. SIMMONS.

MESSRS. PAYEN AND CHEVALLIER, so far back as 1830, and even before, determined that the yellow secretion of hops, a bitter and aromatic element, was the sole source of the flavor, the strong odor, and, in fact, the active principle; and that the bracts of the cones which were not touched with the yellow substance had no more aromatic odor or flavor than dry hay. They also ascertained that this yellow powder or secretion is found in varying proportions in different kinds of hops, and hence their real and useful value differs materially.

The following is the mode in which these able chemists made the analysis, which is more mechanical than chemical: "The strobiles, or cones, of the hops are taken when well dry, and the foreign matters which they contain are separated as much as possible; they are then placed on a fine horse-hair sieve, pressed with the hand, and the sieve shaken; the pulverulent secretion passes through the meshes of the sieve, leaving the bracts on the top. These are again submitted to pressure and agitation, to separate any more of the yellow powder which may have escaped, until nothing is left but the waste bracts. Care, however, must be taken not to crush or bruise these, so that none may pass through the meshes to augment the bulk of the sifted powder. This product can then be weighed and preserved in closed vessels."

Dr. Ives found, on analysis, lupulinic grains to contain—

Tannin	4·16
Extractive	8·33
Bitter principle	9·16
Wax	10·00
Resin	30·00
Lignin	38·33
Loss	·02
	100·00

The following analyses are useful for reference, as showing the percentage quality of the different hops of commerce, chiefly those of the Continent:

SUBSTANCES.	Foreign Matters.	Waste Bracts.	Yellow Secretion.
Poperinghe (Belgium)	12·00	70·00	18·00
Old American	14·30	68·80	16·90
Bourges	0·50	83·50	16·00
Lake Crécy (Oise)	1·80	86·20	12·00
Bussignies	7·00	81·50	11·50
Vosges	3·00	86·00	11·00
Old English	3·00	87·00	10·00
Luneville	1·50	88·50	10·00
Liege	10·00	81·00	9·00
Alost	16·00	76·00	8·00
Spalt	3·00	88·00	8·00
Toul	1·50	91·50	8·00

Turpin recognized in the glands of the hops the presence of two vesicles in which an etherized oil existed, and Raspail, by a more careful examination, found chlorophyl, a resinous substance, an etherized oil, and some gluten in them. Payen and Chevallier analyzed hops from different sources, and they found as a minimum 8 per cent. and as a maximum 18 per cent. of hop dust. It is a well known fact that the hops of different countries are not equally good; the difference in the quantity of the yellow powder may, among others, be one of the causes; but as, in the manipulations which the hops undergo, the yellow powder may be easily detached, it would be wrong to conclude from the experiments of Payen and Chevallier that in the hops, as they are in the field, there exists such a difference in the quantity of powder; during the carriage a small quantity may in some way or other be lost.

Wimmer found in 100 parts of hops 20 parts of powder to 80 parts of scales. But as it was impossible to separate from the flowers all the particles of yellow dust held, he was of opinion that about half more ought to be added. He found by analysis the following percentages:

SUBSTANCES.	Folioles of the Flower.	Yellow Dust.	Folioles and Dust together.
Volatile oil	...	0·12	0·12
Tannic acid	1·6	0·7	2·3
Bitter substance	4·7	3·0	7·7
Gummy "	5·8	1·3	7·1
Resinous "	2·0	2·9	4·9
Vegetable cells	64·0	9·0	73·0
	78·1	17·02	95·12
Watery extract	12·1	4·9	17·

LUPULINE.

This name has been given by Ives to the yellow dust which covers the folioles of the female flower of hops. Later on, Ives, Payen, Chevallier, and Pelletan gave the same name to the bitter substance contained in the dust.

Besides the oil which is obtained by distillation, and the tannic acid, which is also not without value as regards the preparation of beer, the resin and the bitter substance especially deserve to be distinguished. They are both obtained by treating with alcohol the yellow dust of the hops. Water is added to this tincture, and it is distilled, which causes the separation of a large quantity of resin. The tannic acid and malic acid are saturated by means of lime, and the liquor is evaporated. If the residue is treated by ether to further obtain a small remaining quantity of resin, then by alcohol, the bitter substance dissolves in the alcohol, and may be separated from it by evaporation.

Lupuline, seen under the microscope, resembles an acorn in its cupule; it is a gland composed of a hidden cupule, surrounded by a membraneous sac, called the *cuticule*, which contains the products of the secretion, constituting the essential oil of hops.

This essential oil is a clear green liquid, slightly bitter, very aromatic, of the mellow odor of fresh hops; its specific weight = 908 at + 16° C.; it is but slightly soluble in water, very soluble in alcohol, and boils at + 240° C. Iodine and bromine turn it brown and alcoholized sulphuric acid reddens it. The essential oil is composed of an eleoptine and a stearoptine. The eleoptine is a hydrocarbon, $C^{10}H^{8}$, isometric with spirits of turpentine, and distills at + 175° C. The stearoptine is an oxygenized hydrocarbon, $C_{10}H_{18}O_2$, isomeric with valerol, which distills at + 210° C., and is converted by oxidation into valerianic acid.

The chemical composition of lupuline proves the richness of its principles, for analysis has found in it the following:

1. Water.
2. Essential oil.
3. Acetate of ammonia.
4. Malate of lime.
5. Albumine.
6. Gum.
7. Malic acid.
8. Tannic acid.
9. A resin.
10. Bitter extract.
11. A fatty matter.
12. Chlorophyl.
13. Acetate of lime.
14. Nitrate and sulphate of potash.
15. Sub-carbonate of potash.
16. Carbonate and phosphate of lime.
17. Phosphate of magnesia.
18. Sulphur.
19. Oxide of iron.
20. Silica.

In therapeutics, lupuline plays an important part, but the properties of the etherized narcotic extract, and those of a crystalline acid, in very bitter silky needles, which might be called humuline, have never been experimented on, and would probably be found powerful substitutes for opium and quinine.

The *bitter substance of hops* is a yellow solid matter, not very soluble in water, easily soluble in alcohol, less soluble in ether; it is odorless and of a very bitter flavor; has a feeble tendency to combine as easily with the metallic bases as with the acids.

The *resin of hops* may be obtained pure by the action of boiling water. In the pure state this resin is free from all bitter flavor; it is insoluble in water, but is, on the contrary, very soluble in alcohol and in ether. The resin of hops has been the object of research by Vlaanderen. He treated the hop dust with boiling alcohol, then filtered it, added a considerable quantity of water, and evaporated it. In the yellow, cloudy liquor a soft resin of a dark brown color is thrown down; this is separated from the liquor, again dissolved in alcohol, filtered once more, mixed with a large quantity of water, and evaporated, for the purpose of separating as much as possible by this evaporation the oil which remains adhering to the resin. The same treatment is recommended several times, and continued until the resin has lost all trace of bitterness.

The *etherized oil of hops* is a yellow oil, obtained, it is said, in the proportion of 2 per cent. from hop dust by distillation. I have, however, never seen it obtained in such a quantity. The resin retains, moreover, a very large quantity of oil. This volatile oil is more or less soluble in water; it easily dissolves in alcohol and in ether. Its specific weight has been found = 0·908.

Way and Ogston on the one hand, and Hawkhurst on the other, have determined by analysis the constituent inorganic parts of hops. Watts and Nesbit have also effected the determination of them.

The following are their respective analyses:

SUBSTANCES.	Way and Ogston.		Hawkhurst.	Nesbit.
Potass	12	25	19·4	25·2
Chloride of potassium	5	....	....	1·7
" sodium	....	3	....	7·2
Lime	18	22	14·2	16·0
Magnesia	6	5	5·3	5·8
Sesquioxide of iron	2	2	2·7	7·5
				Phosphate of Sesquioxide of Iron.
Phosphoric acid	21	14	14·6	9·8
Sulphuric "	7	7	8·3	5·4
Silicic "	23	20	17·9	21·5
Carbonic "	5	2	11·0	....
Soda	....	....	0·7	....
Alumina	....	....	1·2	....
Chlorine	....	....	2·3	....
Amount of ash per cent.	8	6	....	....

It is chiefly to its bitter principle that the physiological action which hops exert is generally due; this action has been compared to that of opium, and a narcotic power is generally attributed to hops, but I do not find sufficient reasons for this assertion.

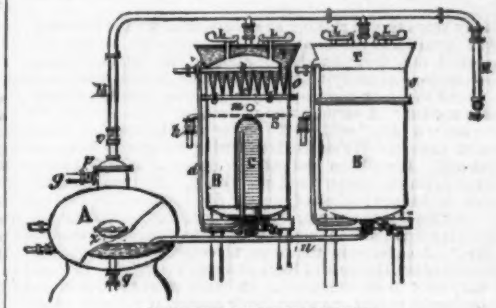
In 1863 Lermer suggested the presence of a peculiar alkaloid in hops. Griessmayer's recent experiments seem to prove the existence of a peculiar volatile alkaloid, which he named lupulina. The concentrated aqueous decoction of ten pounds of hops was distilled with potassa or with magnesia, the distillate neutralized with muriatic acid, evaporated to dryness, treated with cold absolute alcohol, to remove sal-ammoniac, the alcoholic liquid heated to boiling, and evolved, when much muriate of trimethylamina crystallized. The filtrate evaporated in a water bath, and finally, spontaneously, the residue redissolved in water, in a narrow cylinder, agitated with potassa and ether, and the ethereal solution evaporated spontaneously. The remaining alkaline liquid had a peculiar odor, reminding of conia, and a cooling, but not bitter taste. It soon separated in small crystals, and finally solidified completely. Other experiments proved that some kinds of hops contain no trimethylamina, and finally, also, that the substances present in hops go into beer.

SCHORM'S EXTRACTOR.

To extract the useful principles contained in dyewoods, tanning materials, etc., Mr. Schorm, of Vienna, makes use of the apparatus shown in the annexed figure, and which consists of a closed boiler, A, provided with a man-hole, *s*, and a certain number of extractors, B, that are furnished with safety valves, L, and are connected with the boiler. In the upper part, O, of the extractors, there are arranged refrigerators which are formed of two perforated disks, *b*, whose superposed apertures are connected with each other by conical channels, *c*.

The material to be exhausted is placed between the two perforated bottoms, S, the vessel, B, is covered with the cap, O, and the funnel, T, is filled with water through the tube, *d*, which is provided with a cock, *h*, in order to cool the channels, *c*. The extracting liquid (alcohol, for example) with which the boiler has been filled is then heated by the introduction of steam into the double bottom. The vapors from the alcohol rise in the tube, M, enter at *m*, the extracting apparatus, condense in the cones, *c*, of the cap, O, and flow through the perforated disk, S, over the material to be exhausted. The condensed alcohol is still further cooled by the cold water filling the reservoir, C, which is placed in the extractor, B, and collects beneath the perforated bottom, *s*, and returns to the boiler, A, through the tube, *n*. The extracts remain in the boiler, while the alcohol volatilizes anew, and passes several times again over the material to be exhausted.

The operation is continued until a trial sample taken out through the pipe, *r*, shows that the alcohol is no longer dissolving any extractive matter. Several extractors, B, are always used simultaneously, and cocks which are suitably located on the pipe, M, permit of directing the alcoholic vapors at will into one or the other of the apparatus. While



SCHORM'S EXTRACTOR.

one of the extractors is being filled and another emptied, the others continue to operate; so that the work is interrupted only when the extracts are to be removed from the boiler. Then the cock, *v*, of the pipe, M, is closed, the cock, *p*, is opened, and the steam allowed to escape through the tube, *g*. The extract having thus reached the desired degree of concentration, is allowed to flow out through the cock, *q*.

In the hot treatment of dyewoods, barks, gall, etc., steam is let into the reservoir, *c* (whose sides are perforated), and into the cap, M, through the pipe, M, and this, traversing the material, condenses and collects beneath the perforated disk, *s*.—*Dingler's Polytechnisches Journal.*

ANALYSES OF AUSTRALIAN GUANO.

By A. B. GRIFFITHS, F.C.S.

THE following analyses of a recently discovered deposit of guano in Australia may be of some use to the readers of this journal:

	I.	II.
Nitrogenous organic matter and ammonia salts	46·721	46·730
Phosphoric acid	15·021	15·100
Lime	17·999	17·985
Salts of alkalies	1·421	1·405
Sand	2·714	2·713
Water	15·918	16.067
	99·794	100·000

—*Chem. News.*

INDELIBLE STAMPING INK.

THE ordinary stamping ink made by diluting printing ink (which is made of lampblack and linseed varnish) with boiled linseed oil stands pretty well if enough is used, but when poorly stamped will wash off. Dr. W. Reissig, of Munich, has recently made an ink for canceling stamps which is totally indelible, and the least trace of it can be detected chemically. It consists of 16 parts of boiled linseed oil varnish, 6 parts of the finest lampblack, and from 2 to 5 parts of perchloride of iron. Diluted with one-eighth the quantity of boiled oil varnish, it can be used for a stamp. Of course it can only be used with rubber stamps, for metallic type would be destroyed by the chlorine in the ink. To avoid this the perchloride of iron may be dissolved in absolute alcohol, and enough pulverized metallic iron added to reduce it to the protochloride, which is rapidly dried and added to the ink. Instead of the chloride, other salts of protoxide or peroxide of iron can be used. The iron unites with the cellulose and the sizing of the paper, so that it can easily be detected even after the ink has all been washed off. Sulphide of ammonia is well adapted to its detection.

RUPERT'S DROPS.

By L. TAYLOR, B.A.

IT is stated in chemical text-books (for example, Roscoe and Schorlemmer's "Chemistry," vol. ii., part i.; Miller's "Elements of Chemistry," part iii.) that Rupert's drops may be obtained by allowing molten glass to fall into cold water: I find that it is almost impossible to manufacture the drops in such a manner. I have used cylinders of different lengths, with water of various degrees of temperature, with the same result, the glass almost invariably breaking up into a number of small fragments directly it strikes the bottom of the cylinder. The drops may, however, be very easily obtained by using a saturated solution of ammonium chloride—freshly prepared with cold water (6° to 8° C.)—contained in a cylinder about 18 inches long, the increased specific gravity and cold insuring the almost complete cooling of the glass before it reaches the bottom of the cylinder.—*Chem. News.*

CANCER AND ALLUVIAL SOIL.

I SPOKE a short time ago about Mr. Charles Blanc having died of cancer, and pointed to the conclusion that his malady was to be in some degree traced to the alluvial situation of the Palais Mazarin, where he resided. Of that disease, I said that it haunts low-lying riversides and the mouths of streams which serve as sewers. Perhaps it might be of interest to some of your readers to know on what data I have to go. Raspail first called my attention to the fact seventeen or eighteen years ago. He was in Holland, struck with the prevalence of cancer in the low-lying districts, and still more along the mouths of the Scheldt and the Rhine. He at first ascribed the frequency of the malady to the electrical conditions produced by the metallic plates which the women of different Netherlandish localities wear on their heads to support their tall lace and muslin caps; but he also found that in the tidal region of the Seine, where the soil is alluvial, there was a great deal of cancer, although no metal entered into the headgear. He pursued his observations at the mouths of other rivers. They led him to believe that conditions of soil and atmosphere which developed scrofula were also favorable to cancer, a malady which is apt to first show itself in a glandular region. Trousseau used to advise patients in whom he discerned a cancerous tendency not to *se faire du mauvais sang* by fretting, and to try and live where the soil is dry, the air brisk, and the aspect sunny. I have known a good round number of deaths from cancer in those quarters of the city where there are underground water courses, and along the Seine. Count Von Goltz, the Prussian Ambassador for many years at the Court of the Tuileries, lived close to the river. When Madame Louis Blanc was attacked with the cancerous malady of which she died, she had been for some time residing in the part of the Rue de Rivoli nearest to the Seine.

Many years ago, in making an excursion down the Shannon, I was appalled at the number of cancerous old women who stretched out their hands for alms at the landing-places. Near Athlone as many as three miserable beings, with faces on which the disease was greedily feeding, presented themselves together. A carman who noticed that the sight of them gave me "a turn," said: "A power of widows dies round here of cancer. We're used to seeing them, and have got hardened. It's all the fault of the Board of Works, that is paid to drain the country and won't do it. My own mother—heaven be her bed!—died of cancer. She had a bad tooth when the river flooded the house; it ached, her faced swelled up; the doctor lanced it, and in eighteen months' time she was in her grave." A cancerous tumor or ulcer broke down the constitution of the Duchess of Kent at damp Frogmore. It would be very easy to get at statistics showing what geological and atmospheric conditions most favor cancer, if patients on admission to hospital were asked to state in what localities they had been residing when the disease first showed itself. I have never seen a cancerous face in the chalky uplands of Kent, but I have seen a good many about Dartmouth, the Hoo marshes, Woolwich, and Chelsea.—*London Truth.*

LEAD POISONING IN DRESSMAKERS.

LEAD poisoning is often produced in an unsuspected manner. The occupation of dressmaking might be regarded as one likely to be exempt from it; yet a dressmaker just admitted into the Leeds Dispensary, in England, was found to have a distinct blue line on her gums, with simultaneous symptoms, such as furred tongue, inflammation of the lips, and general debility—all signs pointing to the probability of poisoning by lead. The physician in attendance for some time failed to discover the source of the lead poisoning, and was beginning to think that the blue line had been caused in some other way, when he accidently learned from a merchant that silken thread, being sold by weight and not by length, is sometimes adulterated with sugar of lead. He then questioned the patient, and she informed him that it had been a common practice with her, when at work, to hold silk as well as other kinds of thread in her mouth, and that she had done this the more readily with silk inasmuch as it often had a sweet taste. This is a sure indication of the presence of lead, and all thread possessing it should either be rejected or used with caution. It will be found that the silk thread of the best makers is tasteless, whereas some inferior threads are sweet.—*American Medical Weekly.*

IODOFORM IN DIPHTHERIA.

DR. BENZAN reports good results from *the treatment of diphtheria with iodoform.* He applies the iodoform in powder pure, with a camel's hair pencil, the patch of membrane to be treated having first been freed from mucus with a douche or with another camel's hair pencil. He is careful that the iodoform shall cover the whole patch, and yet is equally careful that it shall not be applied in excess so as to be swallowed. The iodoform is applied eight times in the twenty-four hours—six times during the day, at intervals of two hours, and twice during the night. The success of treatment depends upon the efficiency with which these directions are carried out. The author contends that no treatment so effectually suppresses fœtor and avoids general septic infection. Six severe cases of diphtheria were successfully treated by him, and he looks forward to better results than he has been able to obtain by other methods.—*N. Y. Med. Journal.*

WHERE THE RAT IS WELCOMED.

OLD miners have a great respect for rats of the lower levels. They neither kill the rats nor suffer them to be killed by green hands. In the first place, were there no other reason, a dead rat left underground would scent up a whole level; and, in the second place, the living rats devour any bones, scraps of meat, or fragments of other food left in the mines, which would, by their decay, vitiate the air, generally not and unpleasant at best. Rats also give warning when a cave is about to occur. They feel the pressure of the settling ground even before the cracking of the timbers is heard, and come forth upon the floors and scamper uneasily about by scores. For these and other reasons the miners have a friendly feeling toward the rats, feeding and protecting them. In nearly every mine the men have one or more of the little animals as pets, and these are quite tame, coming out of their holes to be fed at lunch time. When rats come into a new drift or crosscut, it is considered a good sign—is thought to mean that the men will strike ore. The other day, while the men were at work in the face of the new west crosscut on the 2,700 level of the Sierra Nevada mine, a rat came in to them, traveling along the line of the compressed air pipe. Some of the new hands wanted to kill it, but the old miners would not allow it to be hurt. They said it would bring luck to the crosscut. So they fixed up in the roof of the drift a box as a house for the rat and placed food near at hand, in order that it might find its new quarters profitable as well as comfortable. There is much talk among the miners about the coming of this rat, and the men on the new crosscut are very proud of it, and have high hopes on account of its presence. Woe unto the man who shall intentionally kill that Sierra Nevada rat.—*Va. Enterprise.*

THE POULTRY AND EGG TRADE OF EUROPE AND THE UNITED STATES.*

EGG IMPORTS OF GREAT BRITAIN.

A GLANCE at the London Board of Trade returns shows that England receives almost her entire supply of eggs from France. Holland and Belgium contribute, but only in a slight degree, to the enormous quantity of eggs consumed in England. The tables, which I have the honor to submit herewith, are compiled from the Board of Trade returns, and they will show the rapidity of increase in importation, as well as the advance in prices. From the Board of Trade returns for March it appears that no less than 199,922,640 eggs, valued at about $3,000,000, were imported into England during the first three months of the present year. I can see no earthly reason why American farmers should not share in the benefits of this trade.

STATEMENT SHOWING THE IMPORTS OF EGGS INTO GREAT BRITAIN FROM 1856 TO 1879.

Years.	Number.	Value.	Average price per 120 eggs.
1856	117,230,600	$1,392,110	$1.60
1858	113,685,000	1,518,085	1.60
1860	167,695,400	2,38[illegible],290	1.95
1862	232,321,200	2,969,065	1.80
1864	339,298,240	4,175,140	1.85
1866	438,878,880	5,528,265	1.90
1868	383,969,040	5,046,425	2.00
1870	430,842,240	5,104,000	2.00
1872	405,701,040	6,970,760	2.25
1874	538,087,440	14,598,625	2.30
1875	580,212,360	10,393,295	2.25
1876	502,534,800	9,320,675	2.35
1877	441,369,920	8,010,190	2.30
1878	448,190,400	7,998,880	2.25
1879	412,935,720	9,958,045	3.00

POULTRY AND EGG INDUSTRY IN FRANCE.

It would appear that fifteen or sixteen eggs are annually imported from France for every head of population in Great Britain; and when it is taken into consideration that France imports no eggs from other countries for home consumption, the importance of this trade to France will at once be apparent. When it is estimated that the importation of eggs from all sources into England amounted to $12,177,750 for the year 1881, and though poultry thrive nowhere so well as they do in the United States, it seems strange that the American farmer has no share in this commerce. I will show, further on, the trouble and expense the European farmer is at in keeping his poultry—a trouble and expense not known to the American, because my experience has been that poultry in America thrive just as well on their "own hook" as when they are fed. The hens lay as well, and are not subject to the numerous diseases known to the breeders of poultry here. Who would ever think in the United States of having shepherds or guards for their poultry, and not only that, but veterinary surgeons? In France such things are known, and all large poultry-raisers have a guard for their fowls. In 1881, it is estimated that 792,000,000 eggs were imported into England, or about two dozen for each man, woman, and child. "If we reckon the population of France at 37,000,000, we find that for every individual in France one dozen eggs are imported into England; and, computing five persons to each family in France, the British public pays to every six families an annual sum of over $5 for eggs," which I propose to show should not only go to the United States, but that we should supply France itself with eggs. It will be perceived from what I have just quoted that France must produce annually a grand total of nearly 2,000,000,000 eggs. The total value for poultry and eggs I estimate at nearly $75,000,000. A million or two short of this I may admit, but not more, and this does not materially affect the great result.

In only a few instances is this great result achieved by large producers. In most instances the middleman pops up and collects the eggs from numerous small producers, and exports them to England. The egg-producing districts of France are principally Normandy, Picardy, Artois, Soissonnais, Vexin, and Brittany.

In each and all of these places every farmer gives close attention to his poultry, and is rewarded by only small profits, the middleman coming in for his share. Nearly every farmer has a reserve for his poultry, and, as I said before, some one to keep watch over them. Good care is given to the roosting place to have it dry, and in most instances near a stable, because a stable is always warm, and the manure in that way is easily utilized, which is no mean item to the French farmer, who has an eye to everything, not even allowing a feather to be lost. Besides the reserve, the fowls are fed twice a day with oats or wheat. It will be seen that in my dispatches, in speaking of agriculture, I always take a Southern standpoint, and treat matters in this line from that. This is simply because I know no other agriculture, being a Southern man. I think our poultry does better when allowed to shift for themselves and pick up their food wherever they can find it. When fed, they become too fat and lazy to lay. A fat fowl does not lay as many eggs as one in a tolerably fair condition; and chickens or other fowls are in this respect like men—they must take a certain amount of exercise in order to thrive well. In France the condition for fowls is not favorable. The running feed that the American fowl finds as a reward for his industry the French fowl misses, and hence must be fed. The climate is damp and cold; therefore special attention must be paid to the roosting place, that, owing to more favorable conditions of climate, is not necessary in the United States. An American fowl does just as well, and, my opinion, better, in a tree than closed up in a house, if provisions are taken to protect it from its well-known enemies, and those precautions are very simple. I have "raised" a great many and a great variety of fowls, and my observation has led me to the conclusion that fowls do better when not closed up in a house as a roosting place.

Nature has made the fowl for the air as manifestly as the fish for water, and my experience has been, when you take them out of their native climate, in proportion they become sickly, diseased, and hampered in their production, and I am convinced that the more food is given them, the more you fit them for the table, but not as producers of eggs. I mention these things more to show the numerous troubles, that the American farmer can avoid, which are known to the French, as well as the expenses incidental to such troubles. I am aware that there are grave and serious obstacles in the way of the American farmer in competing with the French. The greatest is the transportation and the time required in transporting the eggs so as to preserve their freshness. In this one respect, the French farmer has a decided advantage; but, with the proper arrangements on our steamers, American eggs can be placed in Liverpool, Antwerp, Havre, Bremen, and other European ports in almost as fresh a condition as when they left the United States. I have been informed by captains of steamers that ply between America and Europe that they supply themselves with eggs for the voyage in America, and that they last during the round trip. This being the case, this obstacle of time and transportation is not a serious one.

PROFITS OF POULTRY RAISING.

It is estimated that the French farmer realizes a profit from his poultry ranging from 17 per cent. to 50; in some cases it has gone as high as 85 per cent., though the average is not much above 20 per cent. This is an excellent showing for a pretty easy and interesting industry, where a man can nurse his laziness and at the same time make money. It has been estimated by Frenchmen who have investigated this matter closely, that one hen can lay in three years 450 eggs, or 150 per annum, and that by doing this she pays for herself twice in the time, leaving a double profit on the eggs that she has given her owner, and returning him the capital originally invested in her purchase at the end of the time when she is sent to the market, as it is supposed that after passing that period when she is no longer useful as an egg producer is the best time and age for the table. The interest of rent of land, cost of building for roost of fowls, guard, or care-takers for fowls, loss by death from diseases, etc., which is very heavy in France, much more so than in the United States, will more than make the difference in cost of freight from America to Europe, and place the American eggs on the English market cheaper than the French eggs. This is the one great thing that will tell, in the long run, in favor of the American farmer.

POULTRY AND EGG INDUSTRY IN ENGLAND.

In England, M. T. Mainwaring has published an account of his experience as a poultry "raiser," from which I see that from an outlay of £137 15s. 4d. he has reaped a profit of £19 6s., and this in a climate as dismal and cheerless and uncongenial to poultry as it is to vegetation, where the greatest care must be taken, and expenses incurred to which the American farmer is an utter stranger. Where can a business be produced that can make a better show of profits than this? I copy the following from Mr. Mainwaring's statement, in order to show the best breeds of fowls as producers of eggs:

MR. MAINWARING'S EGG ACCOUNT FOR THE MONTH OF JANUARY, 1882.

House.	Breed.	When hatched.	No. of eggs laid.
1	34 black hamburgs	Mar. and April, '81	423
2	32 andalusians	do. do.	242
3	16 langshans	May 30, 1881	93
4	94 crossbreds	Mar. and April, '81	78
5	16 light brahams	May 4, 1881	47
6	25 brown leghorns 10 andalusians 7 black hamburgs	April, 1880	20
7	97 houdans	Mar. and April, '81	418
8	3 dorkins	April, 1881	9
	336		1,330

This table shows a large percentage in favor of the hamburgs in house No. 1. Mr. Mainwaring, beyond question, shows that the hamburgs are the best egg producers. Another statement from London shows equally the superior merits of this bird, the average being in London 139 per hen for the year. The same breed of fowls under the more congenial and more stimulating climate of America, I am sure, would average more than this, with no expense or attention more than the purchase of the fowl. This same account goes on to show that a profit of £1 was realized on an outlay of £4. I could go on without end to show the enormous profits in this industry here in Europe. The statistics have been collected by me in valuable statements and tables, but I have abridged this report as much as possible, and tried to confine myself to the most important facts. I have known this breed of fowls in Georgia (the hamburg) to lay as many as two eggs a day, and, with a little attention to keep them to keep them from sitting, I believe that they could be made to produce in most of our American States from 270 to 295 eggs per annum. The price of eggs in England ranges from 22 cents to 35 cents per dozen, but it is seldom that it is as low as the former. 1881 the price stood at 50 cents for almost the entire year, and has been on the increase for a number of years. Now, let me suppose that the American fowl will not average more than the English fowl, and let me suppose that eggs are only 15 cents a dozen, the 139 eggs (English hen's average) is eleven dozen eggs at 15 cents, $1.65. If eggs should be cheap as 15 cents, the fowl would be proportionately cheap, not more than 25 or 30 cents; but here is a handsome profit, even if the hen should have cost one dollar, and the hen remains, there being no loss in the commodity in which the money was invested.

AMERICAN TURKEYS AND CHICKENS FOR EUROPE.

Thus far I have said nothing about the raising of poultry. There ought to be equally a market found for the American turkey and chickens, in most of the European States. The turkey is never seen here on the table, except in rare cases, such as wedding feasts and the like, save, of course, for the tables of the opulent. In America it is no dearer than the chicken in proportion to its size. I am as sure of its being a marketable fowl in Europe as I am of its being in America, with a little effort on the part of our exporters. There are thousands of well-to-do people in Europe that have never tasted this fowl, and I have traveled in most of the European countries, and dined many times at the *table d'hote* of the best hotels here, and never in my life have I seen it on the

* Report by Consul Tanner, of Liege, Belgium.

table. Now, this is a strange fact, that this bird that so justly ranks as the first for our tables in point of merit should be almost unknown in Europe, while it is within reach, and frequently forms part of the dinner of our laboring classes in America. It is manifestly for the want of effort on our part that this is the case, and I sincerely hope that this effort will be made, and that the American turkey will one day be as well known here as the American hog.

I have, for the sake of brevity, abstained from producing the numerous tables I have been at the trouble to collect, showing the immense profits in a business of this kind here in Europe. Those who know the European climate, know how unfavorable it is, know the expenses that attach to raising poultry here, can at once see the immense advantage the American poulterer has over the European. He has this advantage in everything, if it could but be followed up. His fowls, which can be "raised" with little or no effort on his part, can be made comparatively as great a source of revenue to him as the hog, or his wheat or cotton.

GEORGE C. TANNER,
Consul.

United States Consulate,
Vervier and Liege, Belgium.

A FESTIVAL EIGHTY YEARS AGO.

IN an old Utrecht newspaper, dated Oirschot, Sept. 6, 1807, we find the following narrative:

A singular incident took place here to-day, which is probably without example.

The Lord of this district, being now eighty years old, decided to celebrate his birthday with a gathering of all the persons in his dominion who were eighty years old, or more, without exception of rich or poor.

His Honor ordered for the day, in the Hotel "de Zwaan," a dinner which should consist of different agreeable, healthy, and, for people of high years, not heavy food.

Of the 46 persons invited, eighty years and there above, living in his district, there appeared on the appointed day 38—14 women and 24 men; the rest were prevented from coming by different causes.

Notwithstanding his Lordship had offered vehicles to all these aged folks, but very few made use of them; even those who lived four and five miles away, not being accustomed to ride, preferred to come afoot.

At the table, on which were laid over a hundred dishes in five courses, his Lordship was seated at the head, having on one side a gray headed man of 92 and on the other one of 91 years, who were served particularly by his Lordship in a very careful manner, while the rest were waited on by fashionable women and young ladies of the place with much affection.

Above the table, in the center, hung a green crown, ornamented in gold, and on each end one of withered oaken leaves, ornamented in silver, the one to remind the guests of what they had been, the other, what they were at present.

The nodding heads, the shaking crowns, the trembling hands of many, the silence which reigned during the first of the meal, the soft music that was heard, and the diligent care of those who waited on the helpless, made an affecting appearance in the eyes of many spectators.

During the festival many suitable toasts were instituted by his Lordship; the first contained a congratulation for the high years of his guests; whereupon they drank a glass of sweet wine, and answered by returning congratulations to his Honor High Born, under a repeated applause of "*Hoeze!*" (an old Holland applause).

After the meal ten women made use of the present music, and danced with his Lordship in a merry way the old and here well known dance, "het voetje" (the little foot), while the old men played in different parties, very attentively and with much interest, a "klaverjasje" (a certain game with cards).

At six o'clock in the evening the company parted; and notwithstanding they had eaten very heartily, there was found after an attentive observation and subsequent inquiry, that none of them was incommoded, and that all the guests were on the next day entirely well.

By a personal examination it was found that none of those present had ever been sick.

There was also not one maimed among them, but some of them were crooked by hard labor; all of them had also all their faculties yet, except two who were a little deaf, and one used a pair of spectacles.

The most striking sight was the bald and gray heads, for there were but four among them who wore wigs.

Though there were many feeble and poor among them, every one had endeavored to appear well dressed, and one eighty-five years old wore a blue cloth coat, which he had had made sixty years before, and which he intended by the next Easter, if he then lived, to have turned for the first time.

By adding the years of their lives, the sum was found to reach 3,014 years.

In parting every one thanked his Lordship heartily, and went away well satisfied.

OIL ON TROUBLED WATERS.

THE influence of oil in calming the surface of the sea has been occupying a good deal of attention lately. In a paper to the Paris Academy, Admiral Bourgeois expressed his views regarding it, which are as follows:

The principle is hardly contestable; but the practical results which may follow are the object of serious doubts, which the facts recently announced do not wholly dissipate. The witnesses of those facts generally omit to specify precisely the nature of the agitation which the oil is said to have calmed. There is, however, a distinction to be drawn between the two phenomena whose superposition constitutes the wave or surge.

The first, and the most important, because it agitates the water to a great depth, is the orbital motion of the liquid molecules, whence results the succession of waves that catches the eye; a motion produced by the prolonged action of the wind, and which is often propagated to very great distances from the regions where the wind has blown, and continues long after that has ceased.

The second phenomenon is the horizontal motion of translation of particles of the liquid surface, when they reach the crest of the wave, are disaggregated from it by action of the wind, and by mixture with the air acquire the whitish color of foam. They then fall over in front of the wave in volute forms, the dimensions of which depend on the force of the wind and the size of the waves. The same phenomenon is observed in absence of wind, when the swell from a distance breaks on a beach; only it has another cause, the retardation of the lower part of the wave through friction on the bottom.

When, the wind having ceased, the first phenomenon is produced alone, it is the *swell* which raises large ships as well as small boats, and causes them to roll; but which is not dangerous, except for fixed obstacles, such as breakwaters or jetties, against which the swell breaks.

None of the facts recently cited appear to prove any sensible action of oil spread on the surface of the sea on these undulations, and, perhaps, it would have been prudent to wait till experience had shown the reality of such action before seeking to explain it by calculation.

The second phenomenon constitutes the *breaker*. It is observed in the open sea when a breeze begins to blow, and becomes more marked in proportion as the breeze freshens. Small vessels are in danger from it in the open sea or near shore, when the breaking wave threatens to fill them. Large vessels may receive dangerous shocks from these breakers, especially if they are not protected by their leeway (*dérive*); which, by plowing the sea, weakens the breakers, while the swell subsists.

It is incontestable that the presence of oil, or of any other viscous substance, on the surface of the sea, may hinder the liquid particles being disaggregated under the influence of the wind, and so forming the *breaker*. A fact often observed by sailors in the tropics furnishes an irresistible proof of this. At night, the phosphorescence of the waters reveals the presence in them of large masses of organic substances of animalcules, which give these waters a greater cohesion, and so oppose the disaggregation of particles from their surface. Then the wake of the ship, luminous during the night, hardly produces any whitish foam during the day. The waves thus lose their crests, and the ship, whatever its speed, glides over the sea, leaving hardly any traces of its passage in daylight.

The presence of an oily matter, then, on the surface of the sea, has a certain effect in hindering, not the formation of waves, but that of breakers.

In what measure may this property be utilized in the interest of navigators? That is a point experience has not yet determined. In any case, it is indispensable, in order to its being fruitful, that experimenters should observe, and specify clearly, the nature of the agitation calmed, the wave, or the breaker. The former will perhaps defy all their efforts. The latter seems less difficult to master, and nature, in the vast laboratory of tropical seas, furnishes convincing proof of it.

PROGRESS OF LIFE ON THE EARTH.

MISS ARABELLA B. BUCKLEY lately delivered two lectures before the Edinburgh Philosophical Institution on "The Progress of Life on the Earth." In the outset of her first lecture, Miss Buckley spoke of the rapid advance of knowledge during the present century on the subject with which she had to deal, and mentioned that there were two methods by which this branch of research was being prosecuted—palæontology and embryology. She proceeded to point out that the earliest known life was invertebrate, and that it was only on coming to the Upper Silurian rocks that we began to find vertebrates in the shape of fish. These fish were shown to be covered with heavy plates, and to have a gristly skeleton; and, as throwing some light on the transition from the invertebrate to the vertebrate form, reference was made to the existing lancelet and ascidian.

Tracing next the history of the cartilaginous fishes on to the sturgeons and sharks, Miss Buckley alluded to the double breathing mud fish of our day as helping to explain anomalous ancient forms. The mailed fishes, she said, were very heavily weighted in the battle of life. They lived in bays and estuaries; were too heavy to venture far out; and, when higher animals began to appear, they had not the power to move quickly to make the water their own. They were intermediate dwellers just on the margin of the land; and the battle of life became too heavy for them when the amphibians and the reptiles began to appear. These took possession of the water as well as the land; and then the mailed fish began to give way, and died out, with the exception of eight or nine types. Very small in comparison with their gigantic ancestors, these had taken to fresh water, had crept into the nooks of life, where they were less attacked, with the single exception of the sturgeon. The history of the sharks had been somewhat different. They had not armor; they had a strong gristly skeleton, which, as ages went by, they strengthened; and thus, fighting the battle of life, they had held their own up to the present day, breaking out into all kinds of strange types, such as skates and rays. Before the mailed fish gave way, they sent out an offshoot to take possession of their peculiar kingdom, in the shape of the osseous fishes. These acquired a stronger skeleton, more powerful as a means of pushing their way through the water; while, getting rid of the heavy armor, they began to wear the scaly armor which was so perfect a protection to the bony fish of the present day, and yet was so light as to be no incumbrance.

Passing on to speak of the change from water breathing to air breathing animals, such as began to appear in the Devonian rocks, Miss Buckley showed how light was thrown upon this transition by that which may be observed in the development of the tadpole into the frog.

In further illustration, reference was made to remarkable peculiarities of other living forms; and in answer to the question, at what point the early amphibians broke off from the fish-like forms, it was submitted that the inquirer must go back to a point where fish were beginning to be fish, and there he might find the amphibians beginning to separate. These latter also, the lecturer remarked, fought their way up, and became enormous animals; but they came in contact with the larger reptiles, and had to give up their large forms; they dwindled, almost disappeared, and only in small forms in later times began to make their way into the nooks and corners of the earth.

In her second lecture, referring to the conditions under which early reptiles lived, the lecturer pointed out that when fish first began to appear, we knew of little but marine life; but there could be no doubt that at the amphibian period there were large land areas, some dry, and some swampy. The origin of the amphibia might seem clear to persons accustomed to look on them as something nearly akin to reptiles, yet the truth was that there was a larger gap, in many senses, between amphibia and true reptiles than there was between fish, and the frogs and newts. It was shown that it was in the secondary rocks where the great age of reptiles was to be found. Nothing was more remarkable in the history of the world than this great life of reptiles. By the time the chalk rocks were reached they were found to be filling every point in land, water, and air, which were now filled with mammalia. In the sea these creatures must have reigned supreme. Various kinds of these animals were described, including flying reptiles. These were powerful fliers and fed largely in the air, yet it was curious that it was not by them that we were to pass on to the birds. The former had the power of conquering the air, yet they were to be swamped by another type which was not to spring from them, but to spring from a type essentially land mammals, and which had no power of conquering the air. When the mammals took possession of the land, birds drove reptiles from their home in the air. After remarking that with the disappearance of reptiles, at the end of the secondary period, came an outburst of mammalian life, the lecturer proceeded to show that in the battle of life mammals have had a great advantage over other animals—an advantage which, she believed, she was the first to bring into prominence. The young of creatures born from eggs, it was pointed out, must necessarily have a hard time of it. In mammalia, on the other hand, the mother protected the young, which gave them a very great chance in life; and as soon as mammalia were traced in the earth they were found to take the place of conquerors.

Allusion was made to the gradual development of social feeling and affection through types of animals as they rose upward. It was pointed out that there was little parental feeling shown by fish, who quickly leave their eggs. Few of them watched over their young, and when they did so it was the father who took care, and not the mother. When we came to the amphibia it was the same, and the same, also, with reptiles, with the exception of the crocodile and a few others. We only come to strong parental feeling in animals with warm blood, four chambers of the heart, and quickly flowing blood through the system, which heightened the nervous faculties and made the mother observant. Social affection was found in birds, and still stronger in mammals, though in the lower mammals affection was weak. In carnivorous animals the affection was purely parental; and it was in the weaker herbivorous animals, who had to combine to protect themselves, that social affection was to be found.

In conclusion, the lecturer maintained that man was as surely linked with the rest of the mammalia as the dog, the lion, or the cat; and she argued that if they went back to the time, which must once have been, when man sprang out from the other mammalia, they would see that, as was the case with other animals, when the struggle became keenest, it would be the degraded links, which hid in the nooks of life, that would continue to live, while the intermediate links would disappear.

VITALITY OF INSECTS IN GASES.

FROM the apparent indifference of some insects to foul and poisonous emanations, as well as the varying sensitiveness of others under similar conditions, it would seem reasonable to conclude that there is a substantial difference in the delicacy of their respiratory functions, which might be indicated approximately by subjecting individuals of various groups to artificial atmospheres of deleterious or irrespirable gases.

This opens a wide field of experimentation both in the methods employed, the reagents used, and the insects examined. More from curiosity than any other motive, I have made some trials in this direction, and the results may at least be tabulated, though they have not been extended enough to admit of any very interesting deductions.

The vessels used in these experiments were large glass bottles, the mouths of which were fitted very tightly with rubber corks; these latter were perforated by two circular holes in which were secured a long and short glass tube, made air-tight in their fittings by the pressure applied to the rubber cork upon insertion. These glass tubes were one half inch in diameter, and served as an inlet and outlet for the gases, upon charging the bottles, and were in turn closed by small rubber corks.

The gases used were oxygen, hydrogen, carbonic oxide, carbonic acid anhydride, prussic acid vapors, nitrous acid fumes, chlorine, laughing gas (nitrous oxide), illuminating gas, and ammonia. The experiments were made at the commencement of the fall of 1881, and but a few species of insects, and those the most common, were obtained for trial, and from want of time the experiments were necessarily incomplete.

Oxygen.—The insects introduced in this gas at first showed slight symptoms of exhilaration and excitement, moving rapidly, flying, accompanied with a restless inclination to jump; this passed away and the prisoners seemed totally unaffected by the excess of oxygen about them, and when finally they succumbed, it seemed in some cases as much due to confinement as to the super-excitatory qualities of the gas they were breathing. Their resistance to the hurtful effects of the oxygen varied extremely, both in individuals of the same species and of different species, but in all cases the gas impaired their vitality only after long exposure to its influence.

Flies (*Musca domestica*) lived in the jars, completely charged with oxygen, from nine through fourteen, fifteen, twenty-three, to twenty-nine hours.

Colorado beetles (*Doryphora decemlineata*) were confined in oxygen for three days, and at the end of that time showed only a slight torpidity, which entirely disappeared when they were liberated, and they resumed their destructive habits apparently uninjured.

The larvæ of the Colorado beetle died in the oxygen after displaying great discomfort under its action after one and one-half day's exposure.

Meal bugs (*Upis pennsylvanicus*) were introduced into the oxygen with the Colorado beetles, and behaved in a similar manner, though noticeably rendered more torpid and inert. They recovered completely upon their release. The common yellow butterfly (*Colias philodice*) fluttered convulsively in the gas, but yielded to any injurious influence exerted by the gas over it very slowly, dying in twelve hours, possibly as much from the effects of its own violence and consequent exhaustion as from the power of the gas.

Moth (*Noctua* ——) unexpectedly exhibited great vitality, living over one and one-half days.

Harvest men (*Phalangium dorsatum*) evinced considerable excitement in the oxygen, and lived twenty-four hours.

Hydrogen.—Flies (*Musca domestica*) were instantly knocked down, and after a few struggles became quiescent, with complete paralysis and plication of legs, in fifteen to twenty minutes, or in some cases in five minutes. Though this prostration closely resembled death, and was so in many instances, yet some of the flies were actually alive for a long time afterward. After twenty-four hours' confinement one fly revived sufficiently to fly, though its legs remained crumpled beneath it.

Colorado beetles evinced a wonderful vitality in this suffocating atmosphere; the relation of two experiments will illustrate this.

In the first case a good-sized vigorous individual was dropped into the bottle, the vessel fully charged, and the openings shut. The hostile atmosphere quickly affected the insect; after a few exertions to break its way out, it fell over, opening the elytræ and protruding its wing membranes, and although occasionally moving, it remained for a long time motionless. In an hour these movements were more

noticeable. The beetle remained here for ten hours longer, at the end of which time it was kicking, and after the least possible admission of air which failed to elicit any signs of relief from its fellow prisoners, commenced to walk. It was taken out in twenty-four hours, and revived so thoroughly as to appear actually unharmed.

In a second case several individuals apparently succumbed at once, but in twelve hours recovered partially and crawled around, and after remaining in the gas almost two days were removed, and were active and lively. There were then introduced into an atmosphere of carbonic acid anhydride, in which they remained four hours, and then eventually recovered, when refreshed by air and food.

The snapper (*Elator communis*) displayed very inferior power of resistance to the noxious effects of the gas, reviving in one case, but feebly in twenty-four hours, and in another found dead in thirty hours.

Moths (*Noctua*—) died in twenty minutes, though instantly upon introduction were thrown on their backs and paralyzed.

A black wasp (*Pompilus unifasciatus*) died in ten minutes.

Carbonic Acid Anhydride.—Flies (*Musca domestica*) were instantly overcome, and died in from ten to fifteen minutes.

A large blue fly, blue bottle fly (*Musca cæsar*), was in a dying state in two minutes, but revived completely upon its release.

Colorado beetles recovered after three hours' exposure, during which time they remained upon their backs almost motionless. The surprising vitality of those previously exposed to hydrogen has been given above.

Bed-bugs (*Cimex lectularius*) also recovered to a slight degree after two hours' exposure.

Carbonic Oxide.—Colorado beetles revived after remaining in this virulent atmosphere eight, twenty, thirty, and forty-five minutes.

Ants (*Formica rubra*) died in thirty seconds and in one minute.

Prussic Acid Vapors.—This poisonous atmosphere acted fatally upon every insect exposed to it, though the indestructible Colorado beetle resisted its attacks more stubbornly than any other experimented with.

Nitrous Acid Fumes.—These fumes acted with fatal rapidity, and destroyed without perceptible distinctions in the time of their death the feebler and stronger insects.

Chlorine.—Chlorine corrodes and disintegrates the tissues, and the insects exposed to a dense atmosphere of this gas were immediately killed. It was therefore used simply as a diluent of the ordinary air. The Colorado beetles lived in an atmosphere overpoweringly odorous of chlorine for one hour, and partially revived upon their release.

Nitrous Oxide (laughing gas).—The Colorado beetle gave in this gas no signs of exhilaration, lived two hours, and died upon removal; probably from exhaustion.

Young of the common grasshopper (*Caloptenus femur-rubrum*) were confined two hours in this gas and were but little affected.

Moths (*Noctua*) died in an hour and a half.

Illuminating Gas.—The gases used were variable mixtures of hydrogen, marsh gas, carbonic oxide, and hydrocarbons, a notoriously dangerous and irrespirable compound.

Colorado beetles were instantly prostrated, folding up their legs underneath them, and gave in twenty minutes scarcely discernible indications of life. After an hour they were taken out and partially revived; some entirely recovered. The paralysis of the legs was the noticeable feature, especially that of the front pairs.

Croton bugs (*Ectobia germanica*) behaved similarly in the illuminating gases, and on being removed after half an hour's confinement recovered almost completely.

Young of grasshopper (*Caloptenus femur rubrum*) evinced signs of life one hour after their introduction, and one individual taken out at that time appeared completely lifeless, yet recovered and was sufficiently strong to force its way out from under a beaker glass. Others left in one day were killed.

A cicada (*Cicada pruinosa*) died in ten minutes. Flies imprisoned in these gases, though they instantly fell to the bottom of the jars in an almost lifeless state, recovered after five minutes' immersion on being removed. A longer imprisonment dispatched them.

It seems quite feasible that insect cases made air-tight could be charged from time to time with ordinary illuminating gas, and their contents thus protected against the inroads and devastations of anthreni and dermestes. Other objects could, of course, be so treated. The cases should be thoroughly tight, and the gas a pure and well-cleaned product. I have kept admirably some specimens in this way, but have noted several aberrant phenomena when specimens were moist. Some fragments of mummy skins which I had in gas were in excellent condition after a long trial; they had been taken from a decomposing subject. On moistening them a rich growth of fungi started out over them, which flourished in the atmosphere of gas for a short time, but after repeated charges sickened and died.

I am convinced that in place of ordinary illuminating gas the vapors of Prussic acid diluted with air or pure carbonic oxide, injected into tight insect boxes, will prove most efficacious for the protection of their contents.—*L. P. Gratacap, in American Naturalist.*

ANCIENT BIRD TRACKS.

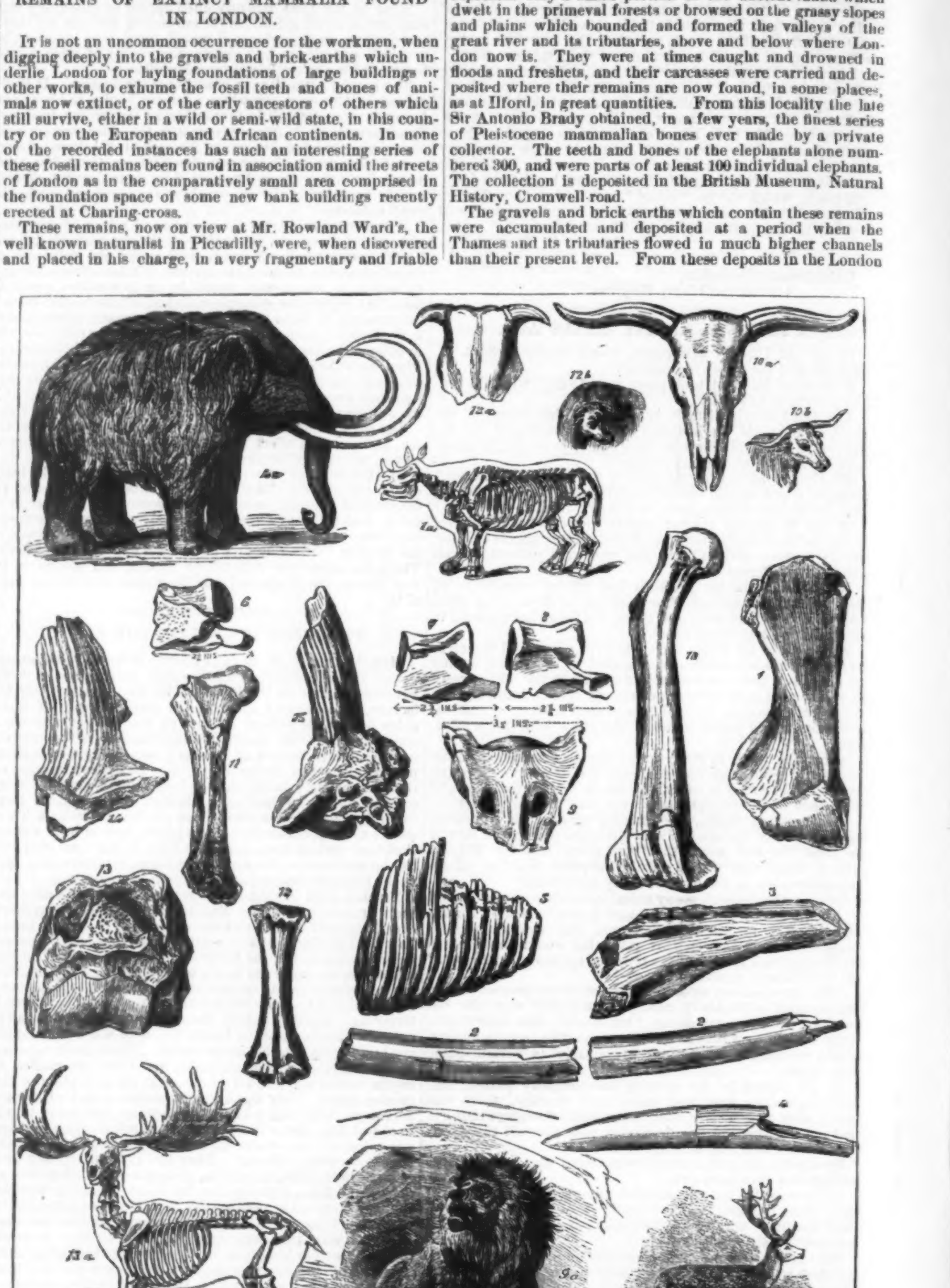
DESCRIBING a visit just paid to the sandstone quarry at Turner's Falls, on the Connecticut River, Massachusetts, Mr. Elias Nason states that workmen are still busily engaged in excavating the bird tracks that have made the quarry geologically famous. The ledge rises 30 ft. or 40 ft. above the river, and consists of thin laminæ of a dark colored and somewhat brittle sandstone. On the faces of the slabs are found the tracks depressed and in relief. They are in general clear cut and very distinct. Some very fine specimens have recently been brought to light. One of them has tracks of an enormous animal, 5 ft. apart, and the tracks themselves (three-toed) are 15 in. long. According to Professor Huxley, who has visited this quarry, an animal making such tracks must have been 25 ft. or 30 ft. in height. Mr. Nason was permitted to take away with him several beautiful specimens, one of which exhibits the delicate tracery of the feet of an insect escaping over the soft mud; another exhibits the ripples of the wave, another the drops of rain, and others have well-defined imprints of the tracks of birds. He also saw the impressions of several kinds of ferns and grasses. Mr Stoughton, who is working this geological mine, considers some of the largest slabs to be worth from $500 to $1,000; but the cost of excavating them is heavy. The whole region is supposed to have been originally covered by the sea. As the waves receded, birds and quadrupeds whose species are extinct, left the impressions of their feet upon the mud, which, hardening into stone, has held them through the ages for the examination of the scientists of the present day. Compared with these tracks as to age, the pyramids of Egypt are but as of yesterday.

REMAINS OF EXTINCT MAMMALIA FOUND IN LONDON.

IT is not an uncommon occurrence for the workmen, when digging deeply into the gravels and brick-earths which underlie London for laying foundations of large buildings or other works, to exhume the fossil teeth and bones of animals now extinct, or of the early ancestors of others which still survive, either in a wild or semi-wild state, in this country or on the European and African continents. In none of the recorded instances has such an interesting series of these fossil remains been found in association amid the streets of London as in the comparatively small area comprised in the foundation space of some new bank buildings recently erected at Charing-cross.

These remains, now on view at Mr. Rowland Ward's, the well known naturalist in Piccadilly, were, when discovered and placed in his charge, in a very fragmentary and friable condition. They have since been skillfully gelatinized and repaired, and were subsequently carefully examined by Mr. W. Davies, of the Palæontological Department of the British Museum. He identified the bones of the cave lion (Felis leo spelæa), and portions of antlers of a variety of the fallow deer (Cervus dama, var Brownii), a molar of the "straight tusked" elephant (Elephas antiquus), and remains of the rhinoceros. In addition to the above, the collection, which consists of about a hundred specimens, comprises tusks, teeth, and bones of the woolly elephant (Elephas primigenius); also the great extinct Irish deer (Cervus megaceros), the red deer (Cervus elaphus), and a number of bones belonging to extinct bovidæ (Bos primigenius). All the above-named were from deposits of the Quaternary or Pleistocene period; while from the comparatively recent or superficial deposits were obtained bones of the Celtic short horn (Bos longifrons), the probable ancestor of the small breed of Scotch and Welsh oxen, the sheep, and the horse. But these represent only a small portion of the ancient fauna which dwelt in the primeval forests or browsed on the grassy slopes and plains which bounded and formed the valleys of the great river and its tributaries, above and below where London now is. They were at times caught and drowned in floods and freshets, and their carcasses were carried and deposited where their remains are now found, in some places, as at Ilford, in great quantities. From this locality the late Sir Antonio Brady obtained, in a few years, the finest series of Pleistocene mammalian bones ever made by a private collector. The teeth and bones of the elephants alone numbered 300, and were parts of at least 100 individual elephants. The collection is deposited in the British Museum, Natural History, Cromwell-road.

The gravels and brick earths which contain these remains were accumulated and deposited at a period when the Thames and its tributaries flowed in much higher channels than their present level. From these deposits in the London district, or within a radius of a few miles, have been exhumed teeth and bones of the lion, hyena, wolf, and fox; the bear, otter, and badger; two species of elephants, the megarhine, leptorhine, and tichorhine rhinoceroses, the hippopotamus, wild boar, and the wild horse. Of ruminants, the aurochs, or bison (Bison priscus), the urus Bos primigenius), the musk ox (Ovibos moschatus), the great Irish deer (Cervus megaceros), the red deer, reindeer, and a variety of the fallow deer; also the beaver, lemming, and other rodents. We have here an assemblage of remains of land animals which in the present day are, respectively, inhabitants of northern and southern climes, but in the past apparently existed under the same climatic conditions. For example, remains of the hippopotamus and the reindeer have been



1. Woolly Rhinoceros, right humerus, wanting upper end. Original, 11 in. long.
1a. Skeleton of Rhinoceros.
2. Parts of tusk of Elephas primigenius, or mammoth. Originals, 19 in. and 21 in. long.
3. Portion of a neural spine of vertebra of mammoth. Original, 7 in. long.
4. Anterior portion of a tusk of a young mammoth. Specimen, 10 in. long.
4a. Restored mammoth.
(The restored mammoth and rhinoceros skeleton drawings show their relative sizes in nature.)
5. Elephas antiquus, second upper molar, unworn. Original, 8 in. wide.
Bones of the Cave Lion, Felis spelæa: 6. Last dorsal vertebra; 7. First lumbar vertebra; 8. Second lumbar vertebra. The bones 6, 7, 8, are inverted in the drawing. 9. Sacrum, under view. 9a. The Cave Lion restored.
10. Bos primigenius, right femur. Original, 18 in. long.
10a. Skull of the urus (Bos primigenius), Post-Pliocene and recent. After Owen.
10b. Bos primigenius, restored by Waterhouse Hawkins.
11. Bos longifrons, left femur.
12. Bos longifrons (small long-faced ox), right metacarpal. Original, 7½ in. long.
12a. Skull and horn cores of Bos longifrons, reduced from natural size, from specimen in British Museum.
12b. Bos longifrons, restored by Waterhouse Hawkins.
13. Distal end of humerus, Cervus megaceros.
13a. Skeleton of the Irish elk. Cervus megaceros (Megaceros hibernicus), Pleistocene. The skeleton of this animal measures from the ground to the top of back, 6 ft 6 in.
14. Cervus elaphus, or Great Red Deer. Base of shed antler measures across the widest part 4¼ in.
15. Cervus browni Dawkins), base of shed antler. Measure across widest part, 4½ in.
15a. Cervus browni, restored. 13a and 15a are drawn to the same scale, so as to show their relative natural sizes.
(Only the Illustrations indicated by simple numbers were exhumed at Charing Cross. Those with the letters *a* and *b* are given to show what the animals were like as far as known.)

REMAINS OF EXTINCT MAMMALIA FOUND IN LONDON.

found associated in the same river deposits, as at Deptford and elsewhere, a warm climate being essential to the existence of the living congeners of the former animal, as a severely cold one is as essential to the existence of the latter. Sir Charles Lyell suggests that the old hippopotami were clothed with a thick covering of hair, like the mammoth and tichorhine rhinoceros, to enable them to withstand the extreme cold of the period. On the other hand, the supposition has been advanced that in the post-glacial period the summers and winters were characterized by extremes of heat and cold; and in explanation of this commingling of bones of animals of divergent climes, it has been suggested that they were migrants, advancing and retreating with the seasons, and alternately occupying the same feeding grounds.

With regard to the lion, the principal interest lies in the fact that it is the first time its remains have been recorded as having been found in London proper. They have been previously found in other places in the Thames valley, notably at Ilford and Crayford respectively, on the Essex and Kentish sides of the river. They are comparatively rare in river deposits, but its bones occur abundantly in many caves, and especially in some in the Mendip range of hills in Somerset, which have yielded an enormous quantity, and of which a large series is preserved in the Taunton Museum. Its existence in England points to the period when Britain was linked to the mainland of Europe, over which it freely roamed, and left its remains in many places. Although formerly considered as specifically distinct from the existing lion, Messrs. Sanford and Boyd Dawkins, who have carefully studied and compared a large series of fossil bones with the bones of recent animals, state that, with the exception of greater size attained by some individuals, the fossils are indistinguishable from the bones of the living lion. Professor Boyd Dawkins thinks the lion retreated southward from Britain, France, Germany, and Italy before the dawn of the prehistoric epoch.

The portions of antlers of a variety of the fallow deer (Cervus browni) have a special interest, inasmuch as they are the first which have been discovered in the older river deposits in London or its neighborhood, and also for the further evidence they give of the former existence and subsequent extinction of the species in Britain, and long antecedent to its reintroduction by the Romans. The first evidence regarding its former presence in this country is founded on a large series of portions of antlers derived from a Pleistocene deposit at Clacton, in Essex, and now preserved in the National Collection.

The frequency of the discovery of the remains of this old British fauna shows that the ox, bison, and deer, and the elephants and horses roamed over their fertile feeding-grounds in large herds; and with this abundance of food the carnivora, lion, hyena, wolf, and bear also abounded, as evidenced by their remains found in caverns and river deposits

As compared with the preceding, the remains found of the hippopotamus, rhinoceros, and other forms are few.

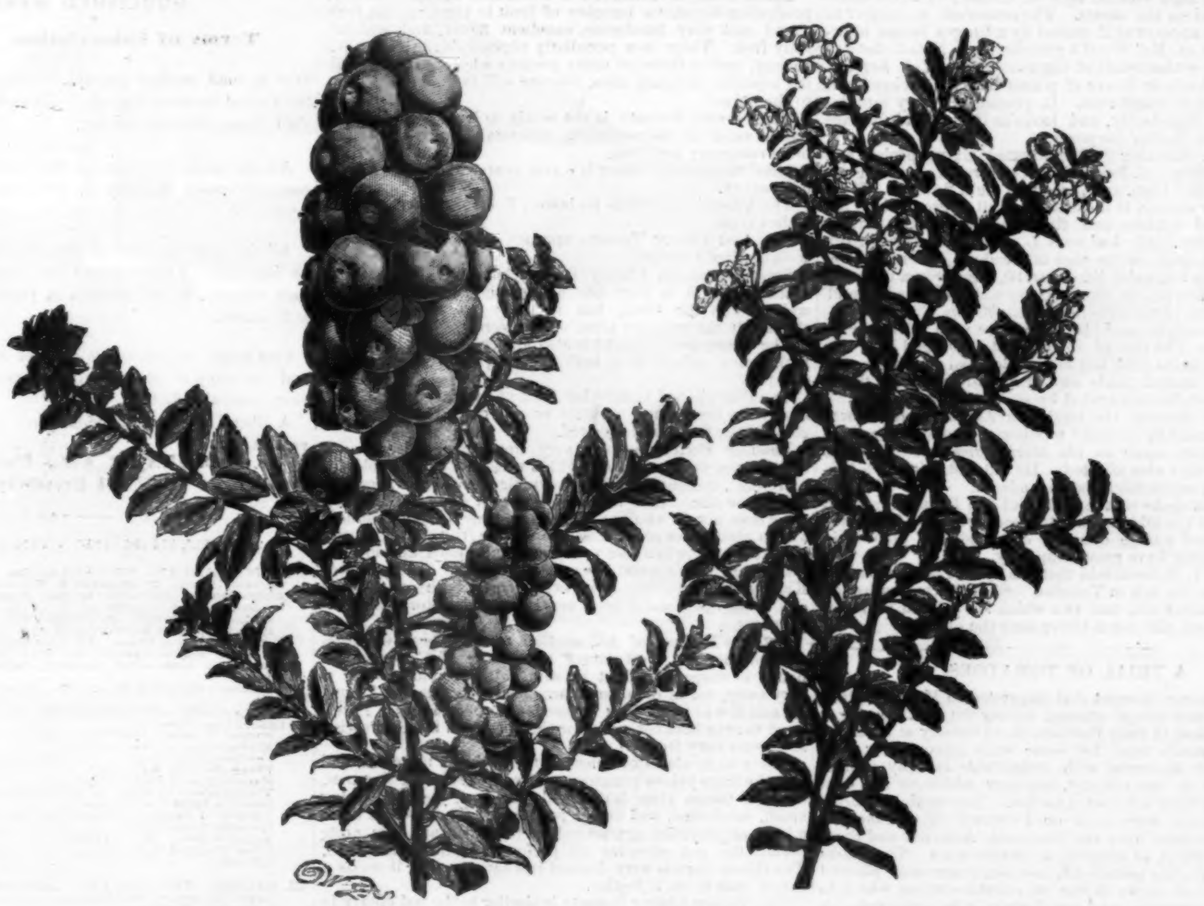
Of these old denizens, the two species of elephants, the three species of rhinoceros, the great Irish deer, and probably the hippopotamus, are absolutely extinct, while the lion and hyena still survive in Africa and Asia. The wolf, the brown and grizzly bears, lynx, and wild boar, though long banished from Britain, are found in many places in Europe; and the musk ox and reindeer flourish in Arctic regions.

We may mention, for the benefit of those hereafter interested in these discoveries, that the collection will be hung on the walls of Messrs. Drummond's banking establishment, being their property.—*Illustrated London News.*

IN the Elm Colliery, Buckley, Wales, a mineral oil has been discovered which yields a very bright flame with very little smoke. As yet it is not known how valuable it may be commercially.

PERNETTYAS.

"DOWN South," as far as any one can go without leaving the mainland of South America, grows a group of low-growing evergreen shrubs, hardy as they can well be, with neat, leathery, shining green leaves, sharply pointed at the tips, and with clusters of white, waxy, bell-shaped flowers, succeeded in due time by globular berries, usually of a crimson color. These are pernettyas, of which the one best known is P. mucronata. Recently Mr. L. T. Davis, of Ogle's Grove, County Down, showed at one of the meetings of the Royal Horticultural Society an interesting selection of seedling varieties remarkable for the beauty of coloring of their berries, which ranged from white to maroon—almost black. Our figure represents a form which we met with recently in the nursery of Messrs. F. & A. Dickson, of Chester, under the name of P. floribunda. The leaves and flowers are smaller than those of P. mucronata; in habit we are assured that it is more free flowering, and the crimson berries are larger.—*The Gardeners' Chronicle.*



PERNETTYA FLORIBUNDA.—FLOWERS, WHITE—BERRIES, CRIMSON.

LILIES AND THEIR CULTURE.*

A PAPER upon the subject of lilies and their culture was read by William E. Endicott, who commenced by stating that the genus Lilium is found throughout the whole of the north-temperate zone, and nowhere else, with the exceptions of a few East Indian species, which grow at such altitudes as to be in a temperate climate. There are now fifty species known, and perhaps sixty or seventy varieties, so that we have about one hundred and twenty distinct forms of this genus with which to decorate our gardens. Some of these are much more beautiful than others, and the essayist thought all would agree that the dull ocherous reds and yellows of some species are less pleasing than the pure white of *longiflorum* or the brilliant scarlet of *chalcedonicum.*

The showiest of lilies is unquestionably the *auratum.* It is not suited to pot culture, and the size of its flowers makes it look out of place when so grown. A clump of it in bloom is a fine sight in a garden. It is well known to possess a delicacy of constitution, owing to which the bulbs, after flowering pretty well for a year or two, dwindle and die. The essayist said he had planted great numbers in all soils, and positions, but all have gone the same way, except a lot of six planted ten years ago in ordinary garden soil. All but two are in good condition; one of these had the shoot knocked off by a careless person, and the bulb of the other was pierced by the underground shoot of another plant. This imperfect success the essayist ascribed to the fact that the bulbs were originally planted twelve or fifteen inches below the surface of the soil, and he has come to the conclusion that all lilies should be planted deep rather than shallow. To get a sound, strong stock of *Lilium auratum,* they should be raised from seed here. This has been found true in England, where such sell for from one-quarter to one-half more than imported bulbs. It is beneficial to this and other species to provide at least a partial shelter for the lower half of the stem. A remarkable point about the *L. auratum* is the variability in the time of flowering, which ranges from June to September, and, stranger still, the plant which flowers early one year will bloom later the next.

The most beautiful lilies, in the opinion of the essayist, are those belonging to the sub-genus Eulirion, or what may be called the *longiflorum* section. They are mostly white lilies, various in form and shading, such as *longiflorum* and its varieties, *wallichianum, neilgherrense, philippinense,* etc. The best known of the group are *longiflorum* and *candidum.* The latter is one of the oldest garden lilies, and in the opinion of the essayist, the finest, on the whole. In moderately moist, rich soil it will grow to perfection with very little care. *L. longiflorum* is marked in some catalogues as not being hardy, but it will endure the winters of this latitude if planted in a light rather than a heavy soil. The essayist had found it difficult to fertilize this species with pollen of *philadelphicum, canadense, superbum,* or others, though it was very easy to fertilize these with pollen of *longiflorum.* In this connection it was suggested that a lily deprived of its anthers, as is sometimes done for exhibition, is deprived of all character, and he believed that some means might be found to keep the pollen inside the anther, so as not to mar the petals.

The native lilies of the Eastern States vary to a considerable degree, and the finest forms are very beautiful and will repay the trouble of getting and caring for them. *L. philadelphicum* is often of a dull red, but sometimes the color is exceedingly pure and intense. *L. superbum* is well named; its pyramids of flowers of various shades of scarlet and crimson mixed with yellow and spotted with brown make it truly superb. It requires more dampness in the soil than most kinds. *L. canadense* is the most common kind, and varies much, but the best forms are hardly surpassed by any of the colored lilies. As usually seen it has two or three flowers, but the essayist once found a plant with a pyramid of twenty-two expanded flowers and three buds, on a stalk seven feet high and an inch in diameter. It was not the result of cultivation, but grew in the gravel of a railroad embankment, which ran down to the water. It illustrates how little we know of the possibilities of any species of plant.

The essayist spoke of the possibility of discovering new varieties of lilies, and though we cannot go to Corea or to India to look for them, we may find them here, and of our own creating. We know by the experience of Mr. Parkman that the possibilities of getting a good thing by hybridizing are not one in a thousand, yet the same experience shows us that successes are possible which may outweigh the 999 failures. What beauties might result from a combination of *longiflorum* and *canadense;* of *candidum* and *philadelphicum;* of *auratum* and *chalcedonicum!* And even different genera might be hybridized, as is proved by Mr. Wilder's experiments with the Gloriosa and a species of lily. It is in hybridization that a real flower-lover will find his greatest pleasure.

Charles M. Hovey said that he began about 1841 with the *Lilium lancifolium,* and as early as 1844 attempted to hybridize it, and produced, among other beautiful seedlings, the Melpomene. If he could have but one species of lily, he would take the *lancifolium;* he thought it surpassed even the *auratum.* He had found the *longiflorum* and other trumpet shaped lilies deteriorate by hybridizing. The *lancifolium* section is one of the hardiest, as well as the most beautiful. He could not say that *longiflorum* is perfectly hardy; his bed had suffered, but this might have been owing to a combination of causes. *L. auratum* is a practically a failure. He had found it improved by planting in a rhododendron bed, where the soil is somewhat peaty, and hoped for further improvement. It seems to be very particular as to soil. He thought that *L. parkmanni* did not propagate rapidly, and partook of the character of *auratum.*

Mr. Hovey spoke of the beauty of our native lilies, especially *superbum,* which he had seen growing abundantly on Cape Cod, and sometimes with as many as eighteen flowers. He had never found *philadelphicum* with more than three or four flowers. Bulbs the size of a pea will flower; the finest he had ever seen were where the ground had been burnt over. If we could, by hybridizing, get a *lancifolium* of a bright yellow or straw color, it would be a great acquisition. *Album* fertilized with *tigrinum* produced a beautifully spotted flower. In hybridizing lilies great caution is required to see that they are not already self-fertilized. The flowers must be opened very early and the stamens cut away. He thought all lilies should be planted about five inches in depth, protecting with a few leaves. The soil for all should be well-drained and light; for *L. candidum* it may be stronger and richer. Mr. C. A. Putnam, who has been

* Essay and discussion before the Massachusetts Horticultural Society at Boston, Jan. 20.

very successful in cultivating lilies, mixes peat freely with the soil, to great advantage.

Mr. Endicott said, in regard to Mr. Hovey's doubt whether *L. longiflorum* is quite hardy, that it grows naturally in a warmer climate than any other we cultivate, and if the shoot is caught above ground it has not the power of resisting cold. He takes up his bulbs and keeps them out of the ground to prevent the shoot from starting. In answer to an inquiry how often lilies should be transplanted, Mr. Endicott says he takes up his *longiflorums* every year to prevent them from starting prematurely; others are allowed to remain without transplanting.

Mr. Hovey said that tiger lilies will stand ten years without transplanting, and *candidum* four or five years, but he takes all up every year. *Superbum* improves by being let alone. The seeds of *canadense* will lie in the ground many years. They grew naturally in his nursery, which was cleared up in 1841, and two years ago a clump came up which he could only account for on the supposition that the seed had remained in the ground when it was cleared up. Mr. Hovey spoke of a lily exhibited in New York as the Bermuda lily, having twenty flowers on one stem.

W. Falconer, of the Cambridge Botanic Garden, said that there were two or three species which he wished to add to those mentioned, among them the little Siberian *pulchellum* and *tenuifolium*. He had found *longiflorum* hardy; the bulblets on the stem flower in two or three years. He saw *melpomene* in England, where it was regarded as the most beautiful of all the species. *L. hoveyi* is as good as *parkmanni*, and not so hard to propagate.

William C. Strong spoke of Mr. Hovey's remarkable success in hybridizing *Lilium lancifolium*, many years ago. The *longiflorum* and similar species are, however, more useful to the florist. He had grown *candidum* under glass as easily as potatoes; the bulbs were planted thickly in the border, and produced six, eight, or ten flowers each on stems six feet high with no sign of disease. Perfect bulbs were produced on the stems. The *candidum* is subject to blight, which appears as if caused by a fungus before blowing. He was at Mr. Wood's greenhouse in Natick the day before, and saw thousands of vigorous plants of *L. harrisii*. There was a bank in flower of plants eighteen inches high, and as strong as *longiflorum*. It propagates very rapidly, and flowers abundantly, and looks as if it would displace *longiflorum* for florists' purposes.

Warren H. Manning had cultivated sixty species and varieties of lilies. *L. humboldti*, a Californian species, grew three or four feet high, and produced eight flowers. *Thunbergianum*, or *elegans*, is the easiest of all to grow; they are good in mixed borders, and, flowering low down, make a brilliant display. He had seen *L. canadense* with thirteen or fourteen flowers on the edge of meadows, where the soil was moist, but the water did not settle. *Superbum* increases rapidly and flowers in almost every soil. He had found little difference in the varieties of *longiflorum*.

James Cartwright said his experience with *Lilium auratum* has been like that of the essayist. He had one row where all the bulbs died but one, which had eleven blooms; he took this up and made two of it, and now has a dozen from it. It can be propagated by scales in moss or sand.

Mr. Hovey thought the blight on *Lilium candidum* was local, and caused by peculiar weather. Two or three years ago, when rain came as his *lancifoliums* were about to bloom, they were also affected. He did not think it a fungus, though fungus might be engendered.

F. B. Hayes spoke of the beauty of the *Lilium superbum* on the line of the Old Colony Railroad, which so fascinated him that he had a large quantity collected and planted in beds, where they have grown superbly.

Mrs. H. L. T. Wolcott said that she found *Lilium superbum* growing on a dry hill in Taunton. She collected bulbs and planted in similar soil, but two which she placed in lower and moister soil did much better than the others.

A TRIAL OF TOMATOES.

It was a happy thought that suggested to Messrs. Sutton & Sons that they should attempt during the past summer a trial of tomatoes at their Portland Road nursery at Reading. There was much need for some such attempt, for new tomatoes have increased with remarkable rapidity of late, and not only in this country, but new additions are constantly being received from America. The seeds of thirty reputed varieties were sown on February 17, and they represented novelties from the Continent, America, and those produced at home, in addition to staple sorts. The plants so raised were duly potted off, and simultaneously planted out in May. A more fitting or suitable spot on which to carry out a successful trial could scarcely be conceived. A border 175 feet in length, facing south, with a wall five to six feet in height behind it, was selected for the purpose, the border being nine feet in width. Five plants of each variety were planted out, one against the wall, and a line of four plants in front and at a right angle with the wall. The border had been carefully prepared, with a view of giving the plants every opportunity of doing their best under the trial.

The wet weather which prevailed, during August especially, caused a vigorous growth, but all the plants were kept clean, healthy, and free from disease. There was constant necessity for thinning out laterals and disbudding, but it was done with a view of securing good crops of well ripened and fully developed fruit. The varieties were planted out without any particular attempt of classification or grouping of types, the sole aim being to see which of the sorts were best adapted for ordinary wall and border culture. Commencing with

Conqueror, an American variety recently distributed by Messrs. B. K. Bliss & Son, New York, it may be described as a fine form of the large red tomato, not so much ribbed, strong growing, and a very free bearer, producing a good crop of even-sized fruit.

Acme is a very free bearing variety, of reddish or rosy-crimson color, but not of a color that looks so nice as a good red skin. It is handsome and of good size.

Powell's Early, a variety sent out by Mr. C. Turner many years ago, is an excellent variety because such a free and continuous bearer, and one of those sorts of which it may be said you can cut and come again. The fruit is much ribbed, but in the eyes of growers who want large quantities of fruit this is not a matter of great importance. It is admirable to plant out for culture against stakes when a wall or any suitable fence cannot be set apart for the purpose. Freedom in bearing is one of its great characteristics.

President Garfield has been well termed "mammoth in size." It is a very large, flattish, and much ribbed fruit; the growth very strong, and the crop good compared with the size, but it is scarcely likely to find favor among growers, because it is much too large for general purposes, and it is not nearly handsome enough to make a good exhibition variety.

General Grant is another American variety, very like Conqueror: scarcely so good in shape, but very free.

Hathaway's Excelsior was very fine and handsome against the wall, but not so good in the open border; it is an excellent variety for house work, being of good size, very handsome, and a large cropper.

Paragon (Vick's) crops well on a wall, but though large and of good shape, is not so handsome as Excelsior.

Key's Prolific was a very prolific bearer in the open border; very large, but not handsome; it is, however, wonderfully free-bearing right to the top of the plants.

Glamorgan is a variety raised by Mr. Crossling, and recently distributed by Messrs. Osborn & Son, and is represented by a very fine and prolific tomato; very large, a strong grower, the fruit somewhat ribbed; crops freely, alike in the open and against a wall.

Stamfordian was represented by a variety bearing large and coarse-looking fruit, but there was reason to think it was not true to name; the form of it grown here grew strongly, and was not at all free in bearing.

Trophy is a very large and free-growing American variety; but very late, and, therefore, does much best on a wall; it is a very strong grower.

Vick's Criterion is a large and very fine flavored variety, rather ribbed, very free and productive, and a good sort for market purposes.

Queen of Tomatoes is a small pear-shaped variety, marvelously free, orange-red in color, and highly ornamental; the fruit produced in large long clusters.

Victoria is a variety of the small pear shaped section, but the actual shape of the fruit is rather that of a Damson than a pear; similar in color to the preceding; a wonderful cropper on a wall, the fruit borne in very large clusters.

Sutton's Royal Cluster is a novel and distinct variety, producing enormous bunches of fruit in clusters; the fruit round and very handsome, excellent flavor, and wonderfully free. There is a peculiarly piquant flavor about this variety, and as there are many persons who are fond of eating tomatoes in a raw state, this one will be found agreeable to the palate.

The Currant Tomato is not nearly so large or so brightly red in color as the preceding; clusters of fruit smaller and more compact; very free.

Sims' Mammoth Cluster is a very coarse and large American variety.

The Valentia Cluster is no better, it is of a large coarse-ribbed type.

The Red Cherry Tomato appears to be quite identical with the Red Currant.

Sims' Mammoth Cherry Tomato bears very large fruit, much lobed; it is very late, a great cropper both on the wall and in the open, but it is by no means cherry-shaped, in the ordinary sense of the word.

The Orangefield Tomato is also a very large variety, with fruit much ribbed; it is both a strong grower and a good cropper.

The Pear-shaped variety has fruit of pyriform shape; it is a very shy bearer, and of little or no practical value. The color of the fruit is orange-red.

Reading Perfection is a very fine and handsome new tomato, not yet distributed. This variety is remarkable for its foliage, having leaves of a very vigorous appearance and very large size. This is the most robust grower of all, and yet it does not go wholly to foliage as some do, but produces a great abundance of large and handsome fruit. It is worthy of notice that when the young seedling plants unfold their leaves they bear a great resemblance to those of the Ashleaf Kidney Potato. This crops very freely both on the wall and in the open, and it is a very fine variety for exhibition purposes.

Sutton's Earliest of All, another novelty, bears medium-sized orange-red fruit, larger than those of Criterion and flatter in shape—it might be said flattish-round—and it is very early, for in the open it was ready to gather on August 13, and it was eight days before any other variety. It is a good variety both for a wall or the open, and is free growing and bears very freely.

There were also examples of the ordinary large red, and also the large yellow tomatoes. Of yellow-skinned tomatoes, Carter's Green Gage is decidedly the best, the fruit being small, handsome, and freely produced. There seems to be a kind of prejudice against yellow tomatoes, and it is quite certain the red varieties are preferred to the yellow ones. The Green Gage is very distinct in character, but it needs a sunny wall to do it justice.

The Yellow Cherry Tomato is similar to the red cherry in size and character, but differs only in the color of the skin.

In addition to the information obtained of the various varieties of tomatoes by means of this trial, the experience gained served to illustrate one or two points of importance relating to the culture of this plant. One is, that tomatoes should be grown in a light soil not too highly manured, as the plants will otherwise go too much to top, and they do not fruit until they have made a certain amount of growth, and have become well established. Another point is that when tomatoes are grown in the open air trained to stakes, a yard in height will be found sufficiently tall for the plants to develop and manure their fruit, and while it is necessary to disbud freely and thin out the laterals, the tops of the plants should not be removed until the crop of fruit is set, and when this has happened the plants need to be thoroughly thinned, that sun and air may be admitted to assist in the ripening of the fruit.

A very large amount of tomato seed is required for sale; a great deal is obtained from America, but very large quantities of tomatoes are grown in Italy to supply seeds for this country. The crop, it is thought, will this season be comparatively light, owing to the prevalence of floods in the tomato growing districts, which have destroyed many of the plants. A great quantity of tomato seed is sent to India, not so much in varieties as in mixtures of all sorts. Indian growers appear to give preference to a variety of sorts over individual quality.—*R. D., in The Gardener's Chronicle.*

EFFECT OF AIR ON SEEDS.

In order to ascertain whether, during the so-called state of rest, any change is going on in the plant or seed, Von Tieham and Bonnier have made some experiments on seeds, extending over two years, from 1880 to 1882. The results are described in the *Bulletin de la Societe Botanique* (xxix., 25). Several packages of seeds were divided in three equal portions, so that each lot contained the same number of seeds of the same kind. One portion was exposed to the open air, so that while currents of air could pass over them, the seeds were protected from dust. The second portion was carefully sealed up in a tube containing atmospheric air, and the third put in a vessel filled with pure carbonic acid. All three portions were kept for two years under like conditions in other respects, and then examined.

First, the seeds were weighed, and it was found that all of those to which the air had free access had increased in weight more than the others, although those kept in a confined quantity of air also showed a slight increment in weight, but much less than the former. Those preserved in carbonic acid gas had not changed in weight.

An attempt was then made to sprout all the seed. Here, too, a great difference was observed; for example, out of 100 peas that were exposed to the air, 90 were capable of germination: of 100 kept in confined air, only 45 germinated; while not one out of 100 confined in the carbonic acid sprouted. Other seeds, rye, linseed, peas, etc., gave different relative proportions, but in all cases those exposed to the open air germinated better than those in a confined space, while none of those kept in the carbonic acid gas germinated.

Seeds differently treated showed different powers of resisting attacks from bacteria; those kept in closed air fell victims to bacteria much sooner than those left in the open air.

Some analyses of the air in which seeds had been shut up showed a varied absorption of oxygen and production of aqueous vapor. N. F.

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